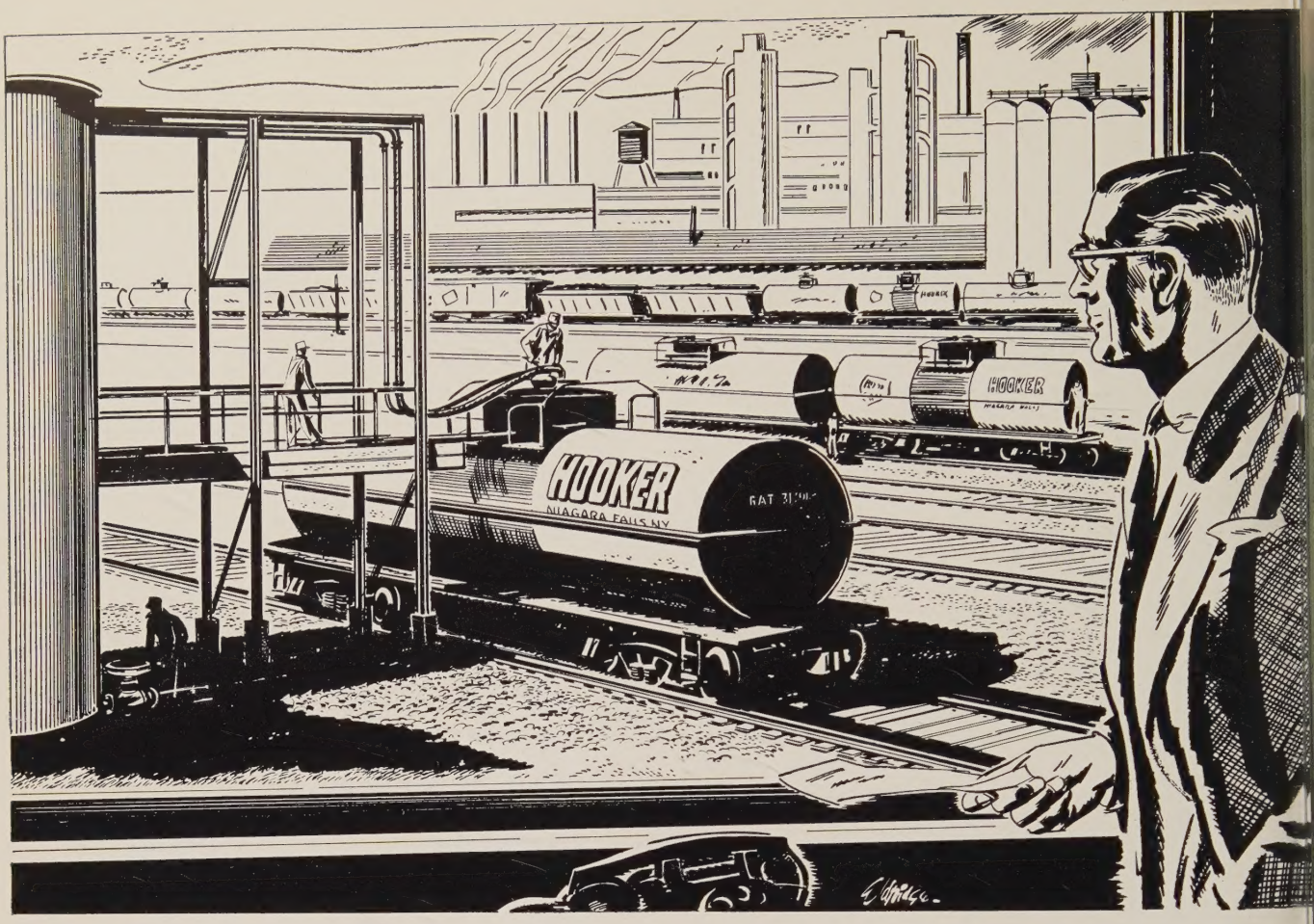
Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

DECEMBER 1953



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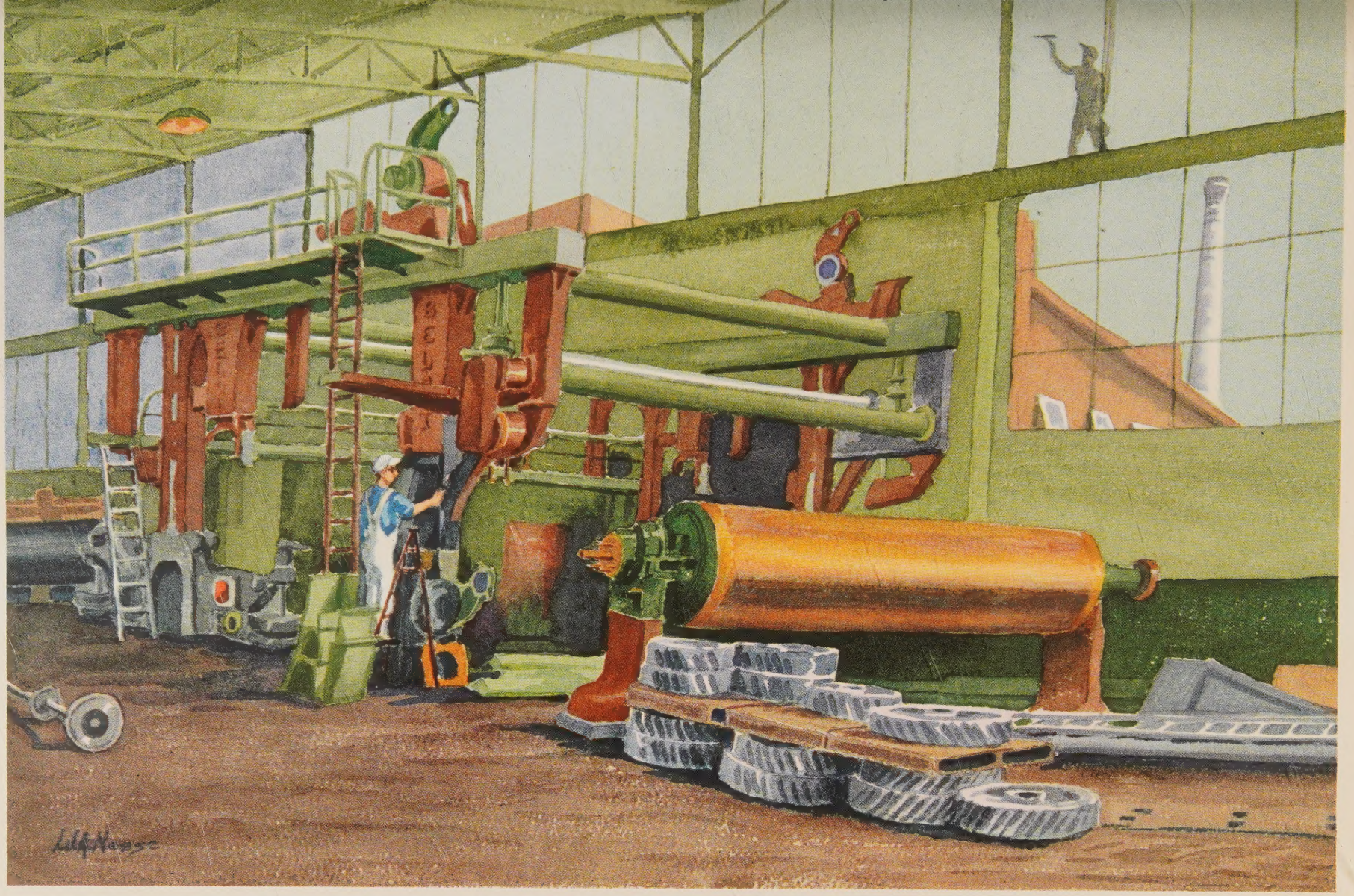

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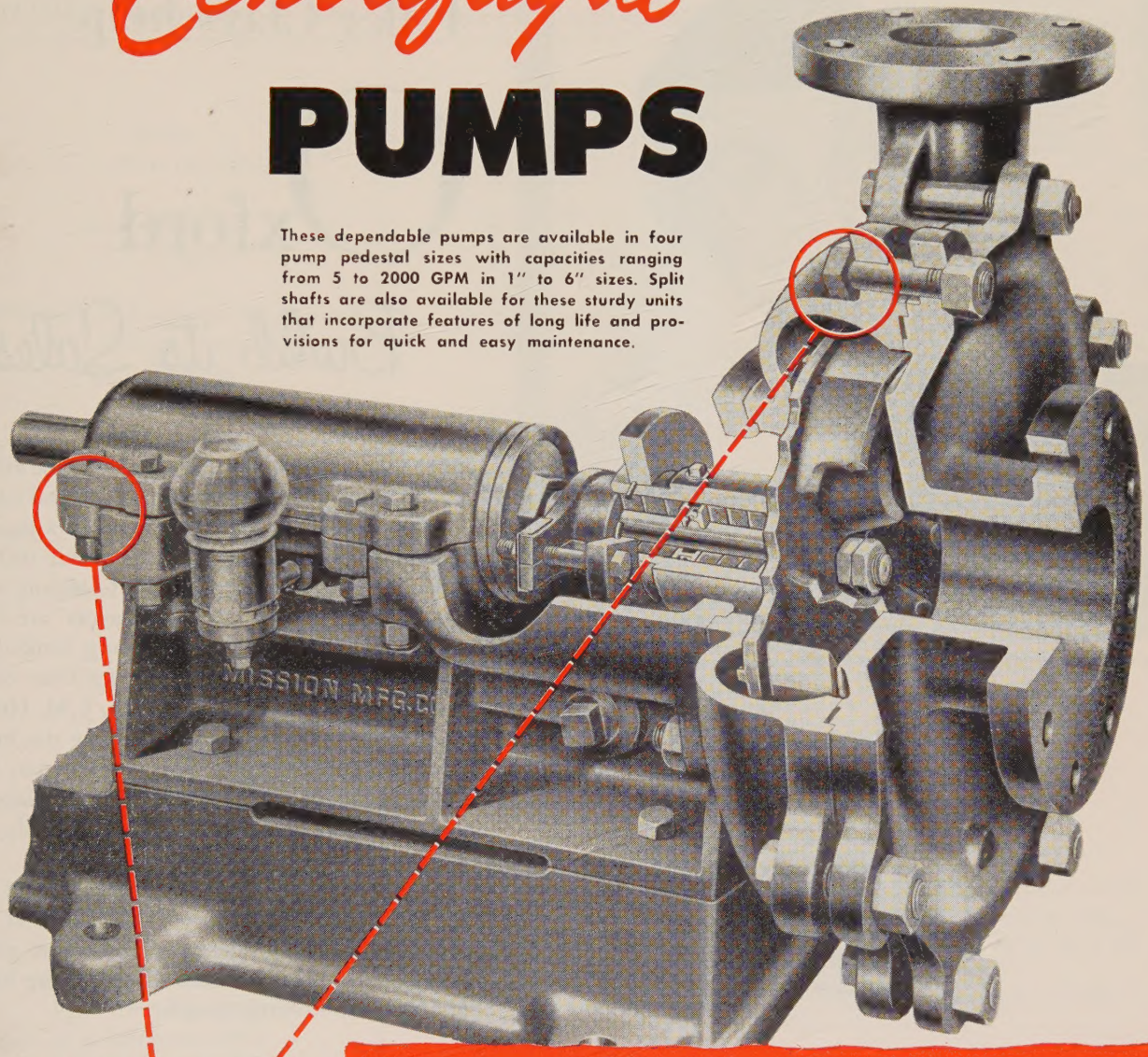

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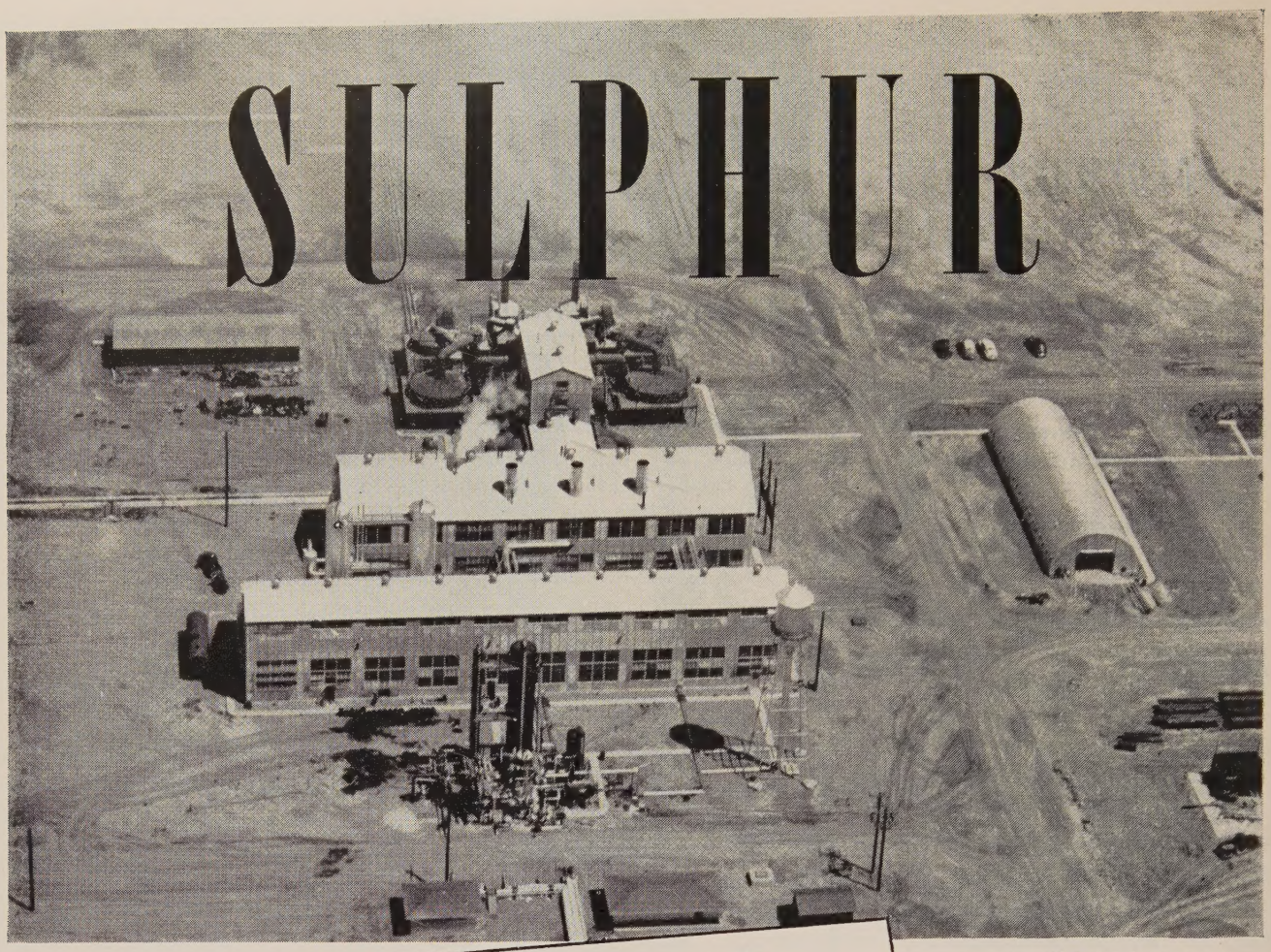

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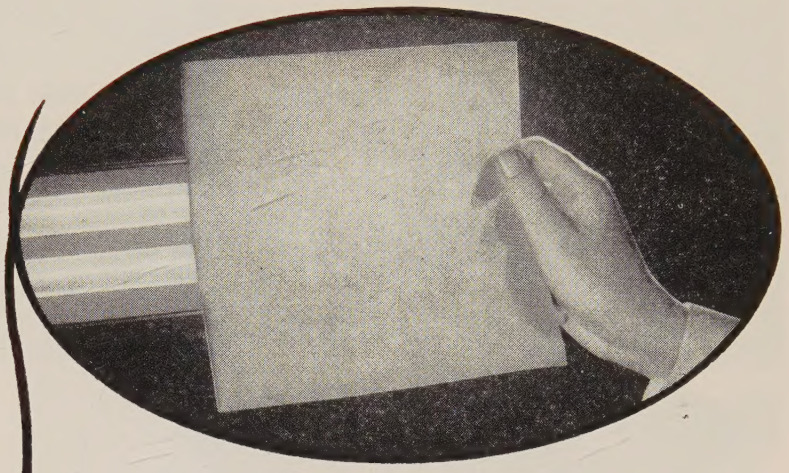
FOAM AT THE MIXING BOX

FOAM AT THE SEAL BOX

FOAM AT THE SAVE-ALL



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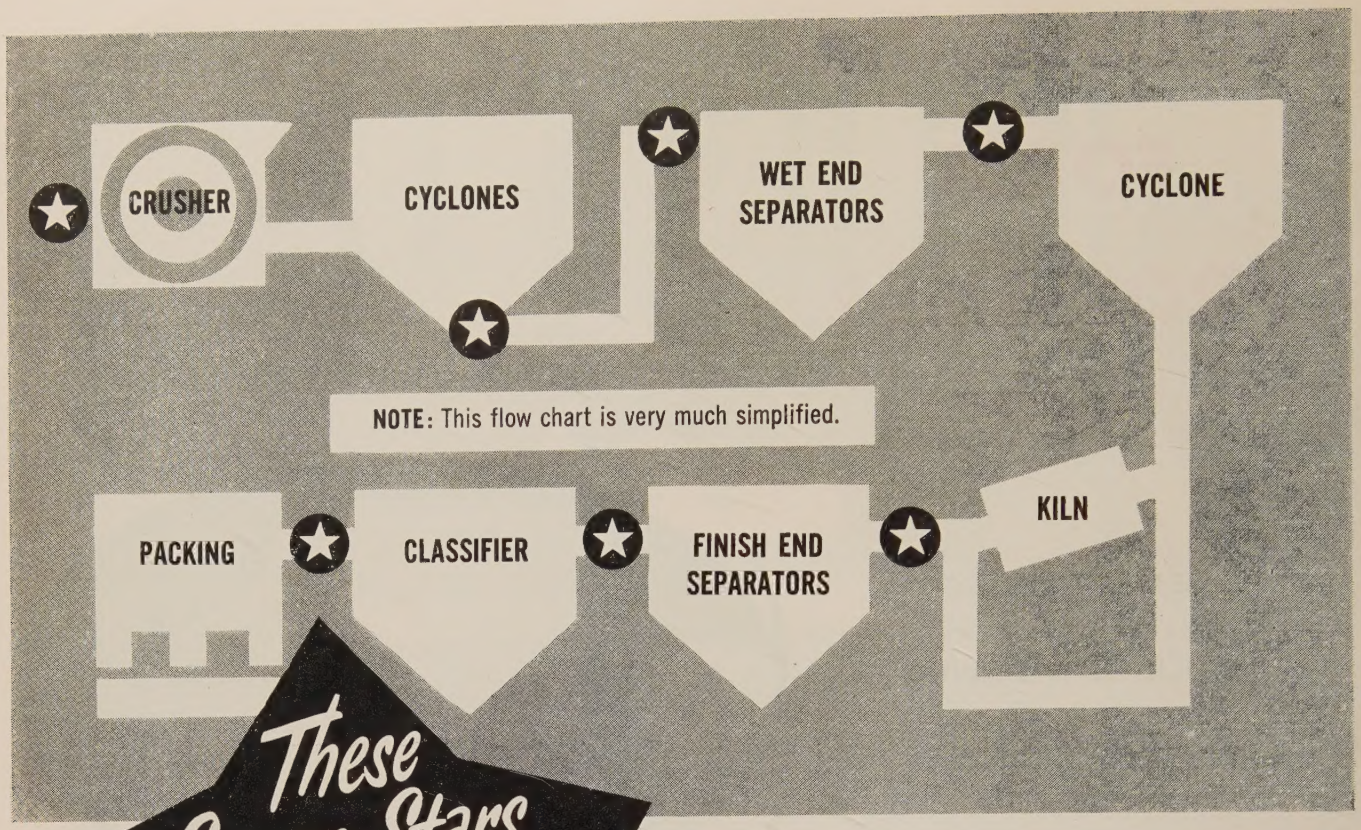

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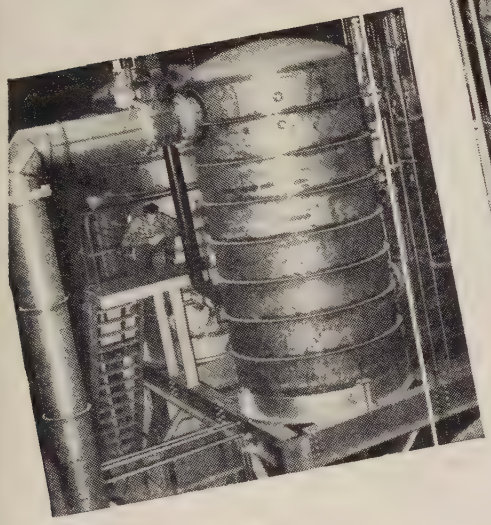

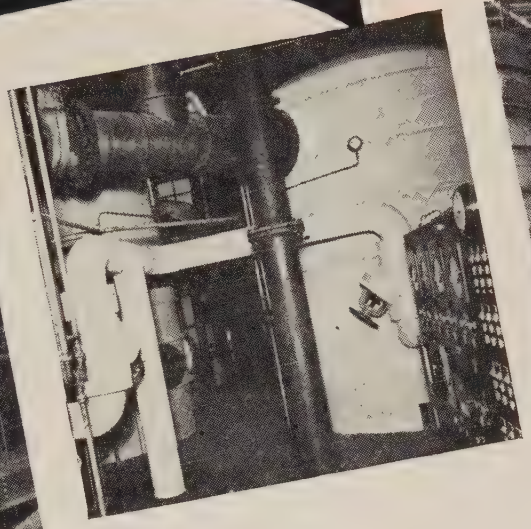

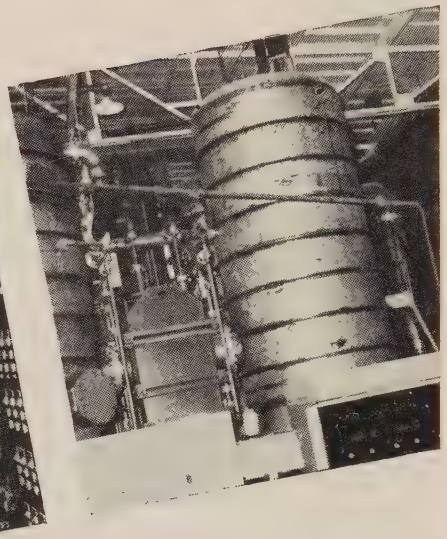

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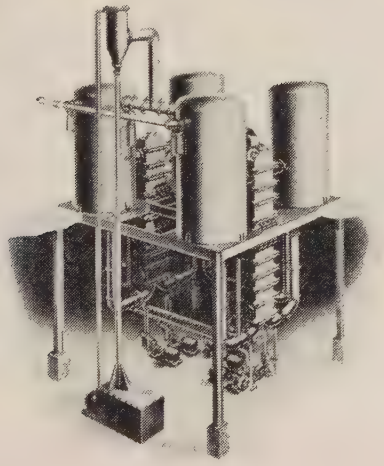

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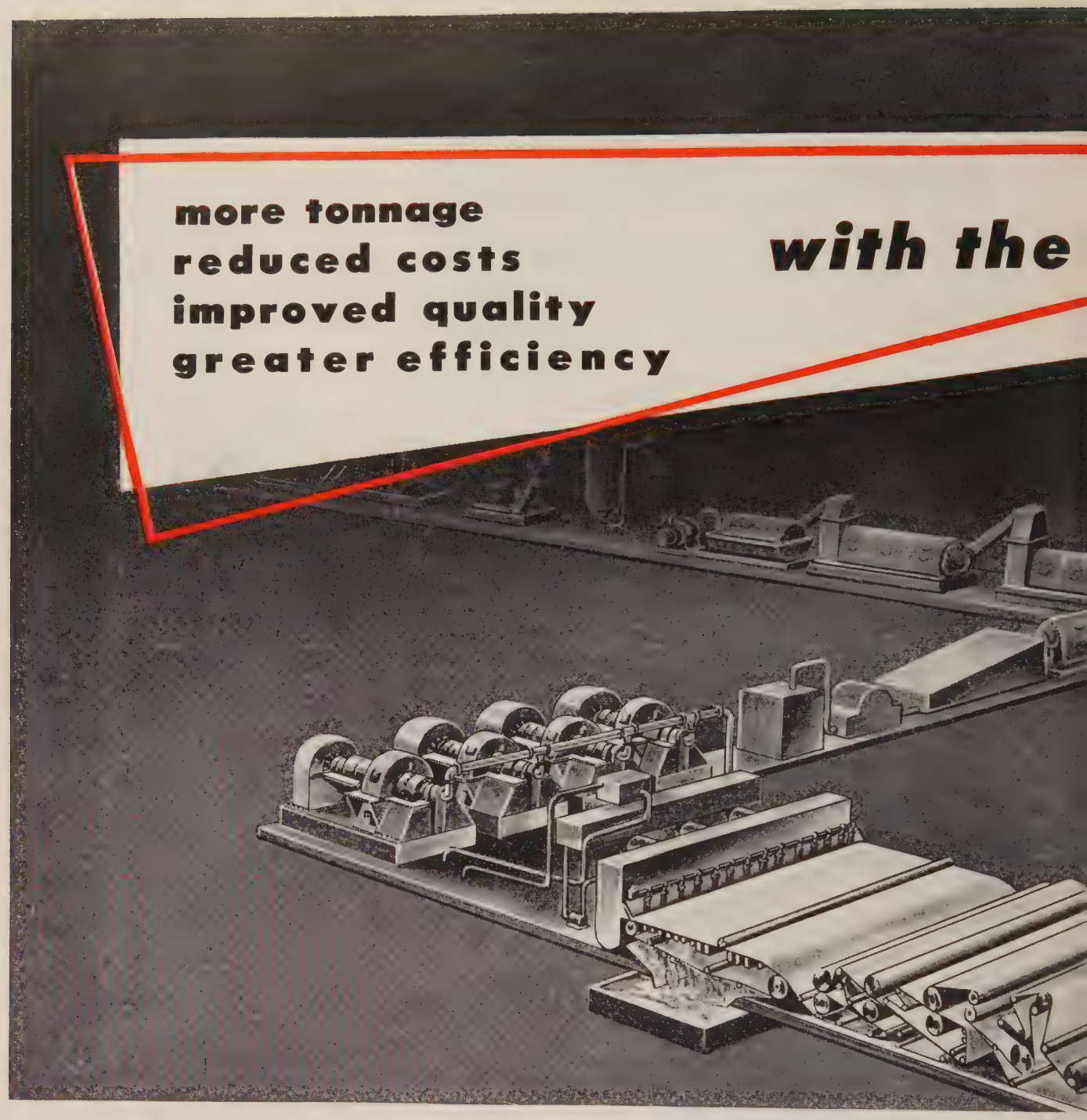
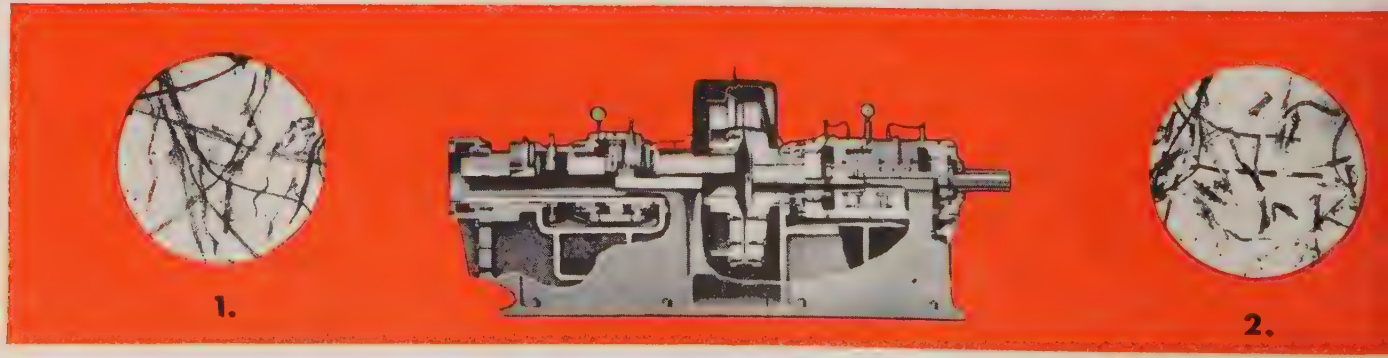


FIGURE 1. A typical Sutherland-treated pulp. Note the length of the fibrils, many of which are still attached to the parent fibers. Thoroughly beaten and refined, the fibers have, nevertheless, not been seriously weakened and chopped up in the process.

FIGURE 2. The effect produced by a Jordan on the same pulp at the same freeness. It can be seen that the fibers have been chopped up into segregated fines, impairing fiber quality and sacrificing many desirable qualities in the finished product



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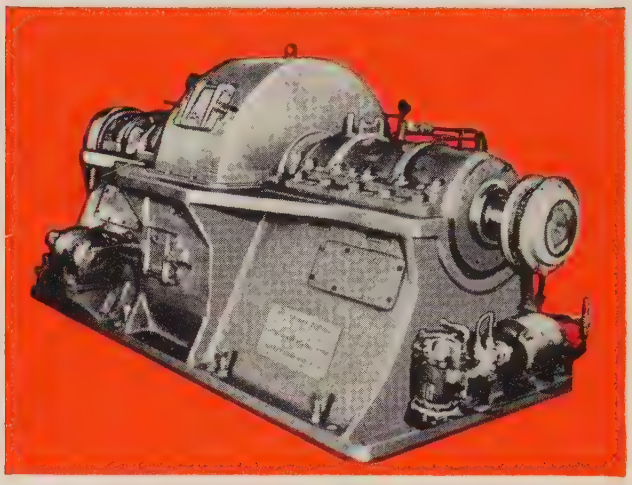

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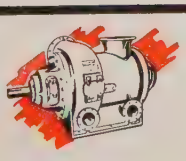

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MANAGEMENT OF RESEARCH

Symposium Sponsored by the Fundamental Research Committee
New York, N. Y., Feb. 18, 1953

Organization for Research

H. N. STEPHENS

PERHAPS it is getting to be a hackneyed expression now, but I still like it: "You can organize for research but you can't organize research." I not only like it but I believe in it so thoroughly that I consider it one of the principal tenets of my professional faith.

That brief introduction pretty well delineates my approach to the problem of research organization. Those of you who have been through the mill and have read about the subject and thought about it can, therefore, anticipate a good deal of what I am going to say. As far as you are concerned, perhaps I might just as well sit down right now, but it is not often nowadays that I get a chance to sound off in a technical gathering and I am going to make the most of the opportunity. As a has-been chemist I do not dare talk on scientific subjects any more, so I have to find other occasions to enjoy the sound of my own voice.

As one further bit of preparation for what you are in for, I might tell you confidentially how I go about preparing a talk such as this. Once I am hooked, I simply reconcile myself to the fact that sometime before I get on my feet to talk, I will have to go through the painful experience of thinking. It may be the Scottish blood in my veins that prompts me to be economical of my limited resources along this line; in any event it is not my practice to squander those resources just for the benefit of my audience. If any thinking is to be done it will be along lines which are of interest or benefit to me. Of course, whatever the audience gets out of it is all to the good.

What I am about to do, then, is to lead you through some soliloquizing I have done on certain background problems of research organization. If there seem to be an unnecessary number of wiggles in the path my soliloquy follows—well, you will have to blame that on the way my mind works.

Now, it ought to be obvious that you are not going to get any blueprint of research organization from me this morning. In my opinion there is no organization pattern that is worth blueprinting with a view to applying it generally to research departments. To me it is putting the cart before the horse to write up a beautiful organization chart, designed for its decorative value on an office wall, and then look for people to fit into the chart—and perhaps last of all, look around for things for the people to do. That seems to be the approach of some of the suddenly affluent companies which have sprung up in recent years and which have acquired along with their affluence an equally sudden yearning for a research department to brag about. To me that is something like establishing a paper operation by starting with a paper mill in the midst of a desert; after the paper mill is finished, building a pulp mill; then finally going off on a hunt for some trees to feed to the pulp mill.

Research should never be regarded as the consequence of organization. Organization is a consequence of research, when the volume of work and the number of people involved make it necessary to formalize lines of responsibility and procedure for the sake of effectiveness. Research is done by people, not by an organization chart, and the people who do it well are probably as highly individualistic as any you will find in any occupation.

The organization chart ought to be considered not as a pattern to which people must conform, but as a pattern developed naturally and logically by people in order to get things done. Each company has its own characteristic job to do, which distinguishes it from any other company. Each company has its own set of key people with personalities and methods of operation of their own. Either of these distinctions might warrant somewhat different organizations for even the most similar pair of companies. Therefore, it always seems ridiculous to me for one research group to ape the organization pattern of another just because the chart looks symmetrical and logical.

Now, suppose we take a look at a typical organization chart and suppose for the sake of illustration that it is of the type which *describes* the organization instead of determining it. Let us trace the general lines of responsibility and the personal relationships involved in order to get an appraisal of what makes such an organization tick.

At the top center, of course, we have the "Big Shot." Then below that, we find an appropriate number of branching lines, both vertical and horizontal, to make it appear that he must be a very busy man indeed. Then, depending on the size of the organization and the extent to which the chart goes into detail, we pass through a variable number of broadening levels until we finally arrive at the level where things are done in the laboratory.

Now, what does a chart such as this mean in terms of operations and human relationships? Does it mean that the man who sits on the throne up in top center tells everyone on the next level what to do; they in turn tell everyone on the level below them what to do, and so on? Sometimes, unfortunately, that is the case, but I think that type of research organization has been dying out and the military method of operation is being almost completely replaced by more democratic methods. In that process of evolution "director" of research is becoming more and more of a misnomer and management of research is becoming the servant instead of the master of the research program.

The "Big Shot" in the more democratic type of organization, therefore, doesn't get that way by throwing his weight around, shouting orders to everyone in sight and, in general, acting like a big shot. Instead, he considers it one of his main jobs to develop an organization which makes it completely unnecessary for him to give orders. You find that he continually solicits the opinions of others below him in the chart and apparently defers a great deal to their opinions. You find that he gives a great deal of responsibility to those below him and encourages and trains them to take responsibility. Indeed, it may appear in the extreme case that his major effort organizationally is to make his own job unnecessary. However, superficial appearances may fool you in an organization of this type.

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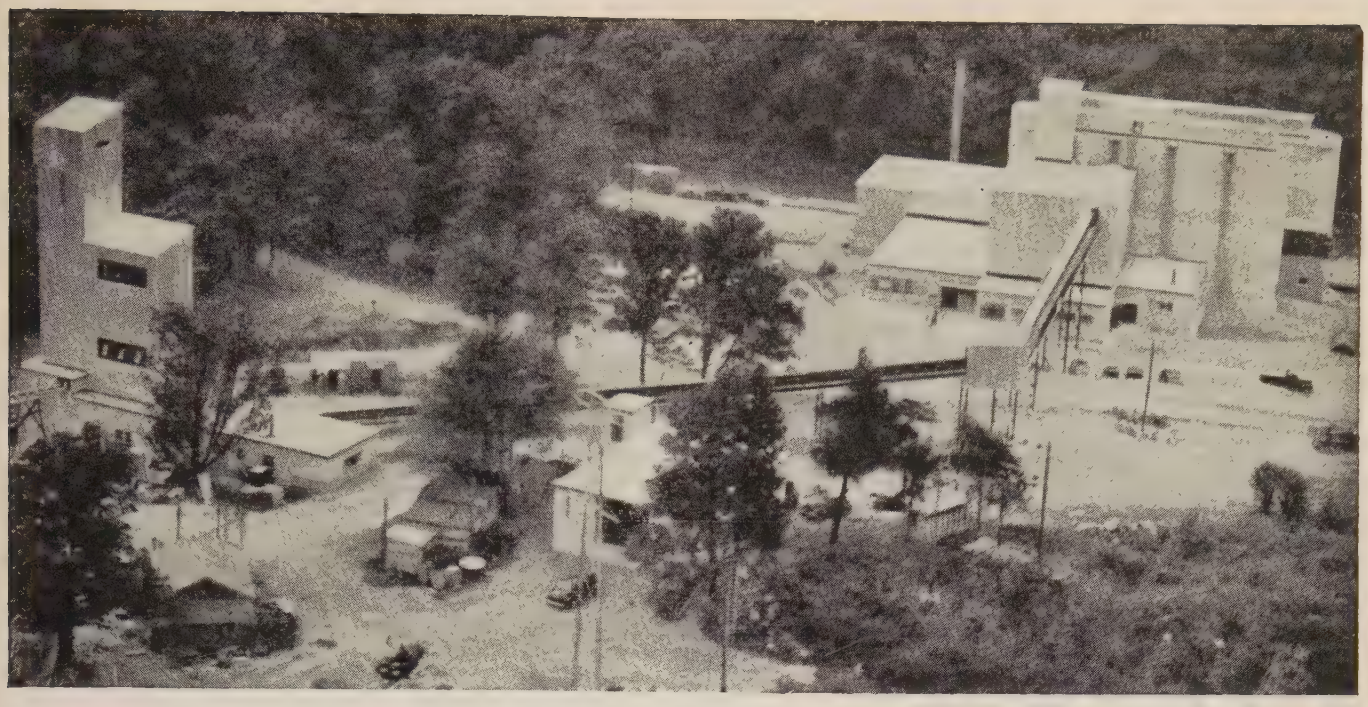

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Sometimes the director or supervisor who creates the least commotion; who does not seek publicity, and who pushes others into the limelight instead of himself, exerts far more real influence on his organization than the one who is a continual center of sound and fury and who always wants to elbow his way into the front row when a picture is about to be taken. Noise and commotion do not always indicate strength, nor does their absence necessarily indicate weakness. The weak man often tries to cover up his weakness by noise and braggadocio. He actually breeds weakness in his organization because of his fear of being shown up by strong subordinates. He is afraid to hire strong people and afraid to allow them to develop. The strong man often expresses his strength in the strength of his organization and actually may avoid attracting attention to himself. His leadership may be expressed in subtle influences behind the scenes, by attracting his subordinates to him instead of trying to dominate them.

Occasionally, of course, a weak man who gets into a position of responsibility will simply try to pass the buck to others to make his decisions for him. That type of man will also pass the buck when things go wrong and will always attempt to find excuses for his own failures by blaming them on others. The habit of blaming subordinates is in itself an infallible sign of weakness and the only remedy is a surgical operation on the organization. One of the hard jobs of leadership is to give credit generously for accomplishments and to take the blame from higher up for failures. The man who can do that gracefully and with humility bears one of the important stamps of leadership. On the other hand, the man who will steal credit from subordinates and shift blame to them should never be allowed to get into a position of responsibility.

In general, positions of responsibility in research should go to people who have qualities of leadership such as those just indicated, in addition, of course, to others more commonly recognized and publicized. Those qualities do not necessarily coincide with the most impressive record of personal scientific accomplishment, or with seniority. Either or both of the latter may enhance the prestige of a leader but are independent of the leadership qualities themselves. Some of the worst mistakes in organization are made by rewarding seniority or scientific accomplishment in terms of organizational responsibility. Such moves may not only be damaging to the organization but to the individuals they are intended to reward.

Obviously, in any scientific activity the basic qualities of leadership must be fortified by at least a minimum of specialized knowledge and intellectual ability. It is equally obvious that the ideal would include excellence in these qualifications. However, the ideal combination is a rare phenomenon and there are far too few of them to go around. Choices, therefore, have to be made between different combinations of strength and weakness in picking people for positions of responsibility. Perhaps the most important and frequent choice that has to be made is simply between scientific ability and leadership ability. In any large research organization the question comes up continually "do we give the job to A, who is a better scientist, or to B, who is a better leader of men?"

This is a question which could be discussed at some length but perhaps it is sufficient for present purposes to make one comment. In actual practice the nod goes far more frequently to the man with leadership ability than to the superior scientist who lacks that ability. As research people, whose job it is to question practices, theories, and even supposed facts, perhaps we ought to ask ourselves whether this practice is sound. I know of some people who think it is not and who are rather cynical about industry's standards in the selection and advancement of technical personnel. Certain university professors (perhaps a smaller proportion than there used to be) accuse us of being dazzled by the "glamour boys" and prejudiced against the people who have the best research brains but who lack personal appeal.

Therefore, it may be worth our while to pause and question whether scientific talent is being recognized and rewarded as it should be in the direction of industrial research. Conversely, it might be profitable to ask whether "personality" gets more than its fair share of recognition. It is easy to ask such questions but very difficult to get definite and reliable answers. All I shall attempt to do is to analyze the situation which gives rise to the questions and make some comments which may point to the answers in a general way.

Before we start any analysis, I think we must recognize clearly that industrial research owes its existence to one dominating motive—to produce a profit. Regardless of the altruistic fervor of certain advertising copy, the hope of eventual profit must underlie every project that is undertaken in an industrial research laboratory. Company X spends its money on research to save the sweet young thing the embarrassment of B.O., not because the members of its management are overwhelmed with grief at her predicament, but because they expect her rescue will be profitable. Company Y spends "years of scientific research" on silky-soft paper products, not because of any sympathetic reaction when coarse fibers rasp on the delicate complexions of others, but because they know that more silkiness means more dollars in the cash register.

Ability to solve scientific problems, therefore, is not the only requirement for success in industrial research. To that must be added as a minimum the ability or willingness to identify one's interest with the interest of one's company, which is, first of all, to make a profit. To attain leadership there is the further requirement of social intelligence, which is quite independent of scientific intelligence. "Research brains" as defined by some pure scientists do not necessarily have any value in the direction or leadership of research. In fact, in the extreme case, the value may be negative.

Now, on the question of overemphasis on personality, I think we must concede at once that bosses are human beings and if a promotion is in the wind it cannot do any harm to be personally liked by the boss. In that sense, what is commonly called personality may influence close decisions in research organizations just as frequently as in any other type of organization. However, I think we might profitably dig just a little bit deeper into this matter and distinguish between personality and leadership, which involves a great deal more than merely being likable. Frankly, it seems to me that the criticism of over-rewarding personality may have more than a little of the "sour grapes" attitude behind it. It is a shallow criticism, based on a lack of understanding of the difference between leadership and what the average person thinks of as personality. It has its roots in the same misunderstanding that causes some professors to criticize and perhaps be a bit envious of deans. The man with depth of scholarship may be unable or unwilling to recognize the importance of breadth.

With these rather oblique comments in the background, perhaps we are now in a position to approach a little more directly the earlier question as to whether there is an equitable distribution of rewards between scientific ability and leadership ability. Suppose we do that by analyzing some well-defined types of research personnel. I think we may start by eliminating the rare individual who is able, essentially through his own efforts, to wrap up a major contribution in a completed package. All that is necessary in his case is to give him what he wants and leave him alone, so he is no organization problem.

The first case we might consider seriously, then, is the man who has outstanding scientific brains but little ability or interest in putting his scientific findings to profitable use. Some people in that category seem to get the impression that, when a successful idea is put into use, the company grabs

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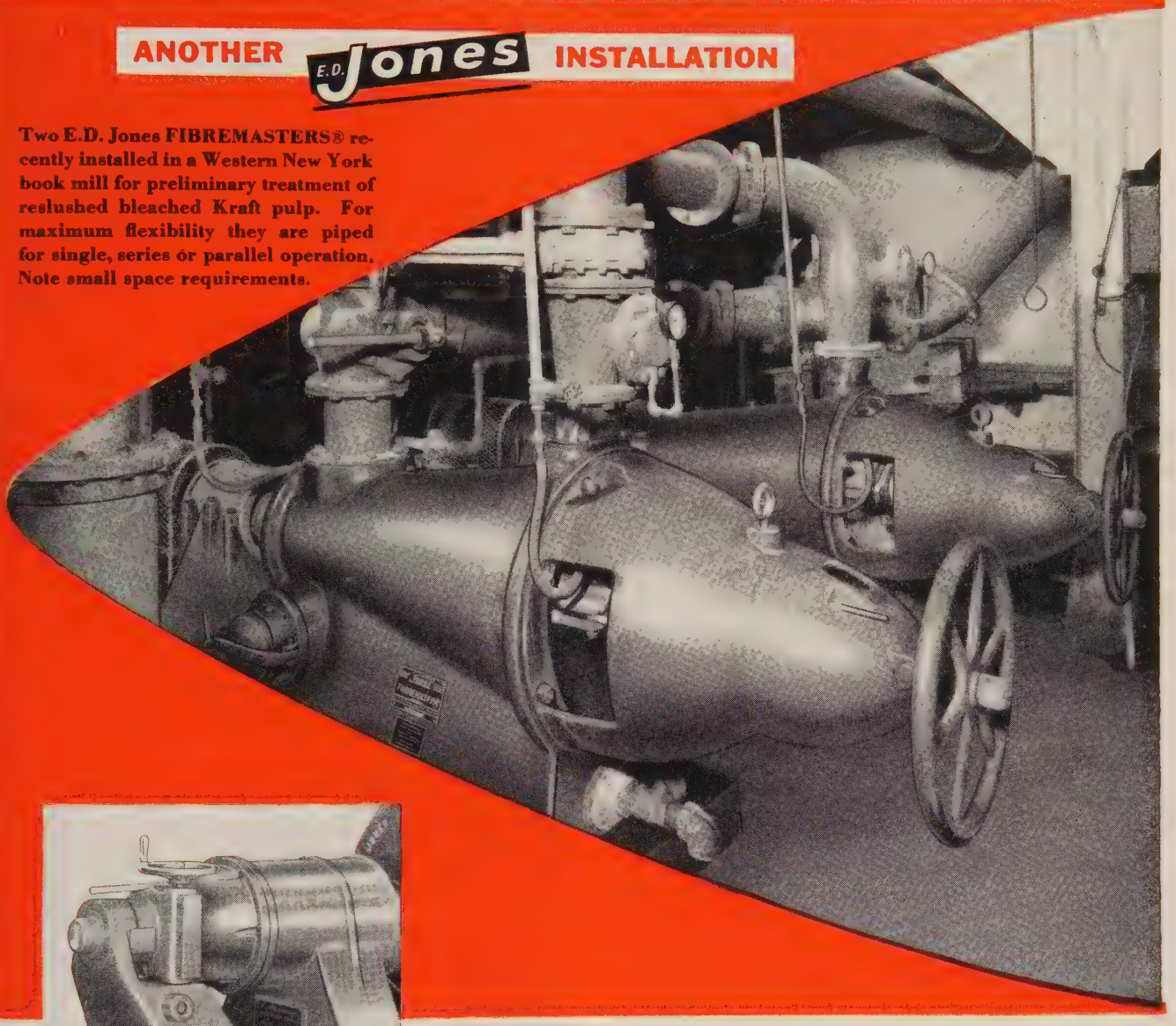

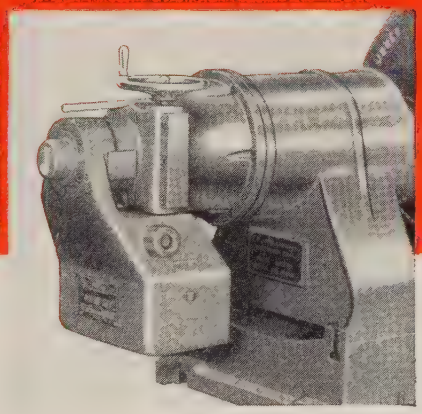

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nearly all the profits and gives only a pittance to the originator of the idea. Admittedly, there are cases in which valuable contributions are inadequately rewarded but often a man of this type may grossly overestimate the value of his contribution to the end result. For example, he may ignore the contributions of many other people in research, development, engineering, production, sales, etc., who may have had an important part in the final success. He may forget that without these people, nothing would have happened commercially. From one point of view, it is only because of the efforts of these other people that the scientific idea or result acquires *any* dollar value. Now, I do not want to depreciate people in this category. They represent an important and valuable part of any research organization and are entitled to adequate recognition in status and compensation. I simply want to point out that it is often a long road between the idea and actual profits to the company and many people may make important contributions before any profits are realized. This ought to be given careful consideration before irresponsible criticisms are made to the effect that management fails to give a fair reward for scientific ability.

Next, we might consider the man who has far more ideas than two hands can carry out, but who lacks the characteristics of leadership. A common device is to attempt to multiply his contributions by providing enough cheap hands to match his brain. On the surface that looks as if it could be a profitable arrangement, but let us take a sharp look at the economics of this multiplication process. In the first place, hands are not nearly as cheap as a comparison of base salaries might indicate. Actually, the total cost of supporting a body in a modern laboratory is not tremendously less than that of supporting a body with a mind incorporated in it. Therefore, multiplication of the output of an idea man by putting bodies at his disposal may not be such a profitable device as it appears on the surface.

Again, cheap hands are not very effective multipliers of output in highly specialized, creative work. An important factor in carrying out such work is continuous critical observation. If that is lacking there will be much waste motion and highly significant results may be completely missed. As a result, there is a rather low upper limit to the number of nonprofessional assistants who can be effectively used.

Now, if we attempt to assign professionally trained assistants to the idea man who lacks leadership ability, in order to supply powers of observation, we immediately get into difficulties. Subordinates in that position are repressed instead of developed. The result is resentment and inefficiency and a sore spot in the organization which is almost certain to affect morale of others not directly involved.

By a process of elimination we seem to be forced to the conclusion that the most effective way to make use of such a surplus of ideas is to put them in the hands of others for independent development. This may work in some cases but it is far from a foolproof solution. The man who is lacking in the qualities which contribute to leadership will probably be jealous of his own ideas and resentful of them being handed over completely to others. He is likely to be critical of the treatment received by his brain children and his natural defense will be to hold back ideas which he is unable to follow himself. In short, he may detract from his personal effectiveness by becoming an organization problem.

Occasionally, of course, a man of this type will contribute such a valuable idea that it overshadows all of the difficulties and problems he has raised. If or when that happens, he ought to be rewarded fairly and without prejudice based on his personal characteristics. Admittedly, this is sometimes difficult to do because rewards are decided upon by human beings and the judgment of human beings is often colored by personal relations. If injustices occur in cases such as this, more often than not they may be traced to the fact that the man involved is his own worst enemy.

Finally, we come to the man with true leadership ability. For purposes of comparison we shall confine our attention to the man who is not particularly outstanding in scientific ability. Is there a tendency to over-reward this type of man just because he is likable personally? Is his reward apt to be out of proportion to his real contribution? Without attempting a categorical "yes" or "no" at this point, let's turn on the spotlight and analyze the nature and value of the contribution he can make.

Perhaps we can start by comparing him with the man who brings only personal scientific talent to the research group. That represents an addition to the group whose magnitude depends on the ability of the man. Then we have the idea man who may, under favorable circumstances, multiply his own physical output by having assistants at his command. Let us say, for the purpose of illustration, that his addition to the group contains a multiplication factor.

Now, compare with either of the two cases just cited, the man who has true leadership ability. I submit that his contribution to a group is not a mere addition but a multiplying factor. I submit further that the multiplying factor applies not merely to his own personal output but to the total output of the group.

That may appear to be a rash statement but I assure you that it is not made merely for effect. I believe it is true. Let me illustrate what I mean.

The general run of research people are highly individualistic. Their basic stock in trade is ideas and they are inclined to be proud of their own ideas and quite frequently rather jealous of them. It is an old truism that two heads are better than one and in the complex problems of modern industrial research I think we can extrapolate by saying that three heads are better than two, four better than three, and so on, with perhaps an upper limit to the extrapolation determined by the complexity of the problem.

An aggregation of research people without leadership leaves it to chance to bring the brains of two or more people to a focus on a given problem. Due to the individualistic nature of the people, there is a natural tendency for them to work individually and in some instances and some environments they may work competitively. In the extreme case they may even work at cross purposes. In these latter instances the total accomplishment will not be even equal to the sum of the parts, but something less. In the worst situation it may be considerably less, due to duplication and waste of effort. That is the sort of situation in which real leadership can step in and make the total much greater than the sum of its parts, by cultivating cooperation. This is possible without contributing anything along scientific lines. Thus, a real leader in a research group can serve as a multiplier of the intellectual output of the group. If, in addition, he contributes scientifically he may increase the multiplying factor.

To me, this is the basic justification for the high dollar value that is put on leadership. Alternatively, of course, we can say that leadership commands a premium because of its scarcity value. However, people who lack a real understanding of what it involves have a hard time appreciating how scarce it really is. Thus, they have a tendency to think that people are chosen for responsible positions on the basis of the more superficial thing we call personality. Put in other words, they feel that favoritism plays a greater part in these selections than real ability. In a well-operated company that simply is not so.

Now perhaps some of you have been wondering with increasing impatience when I am going to get through the preliminaries and get into the announced subject—"organization." The answer is that I am *not*. I believe that anyone above the high-grade moron level can collect books on the subject and find in them such a variety of organization charts that one or other will match the needs of almost any company. In my opinion, the choice of organization pattern is a relatively unimportant incidental. The only important thing is

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that the chart should be chosen to fit the organization. The organization should never be warped into fitting a chart.

To me, the one central factor in research organization which overshadows all others is leadership ability in positions of responsibility. If that is provided, all of the other problems are solved almost automatically. If the man at the top is a real leader, he will recognize and develop subsidiary leadership. If there is strong subsidiary leadership it will perpetuate itself. The true leader recognizes that he has nothing to fear from strong subordinates. Even if they do offer competition from below, that may be to his advantage. It makes him more easily spared for a job of higher responsibility and under some circumstances may actually help his advancement. In the meantime strong subordinates not only earn credit for themselves but reflect credit on their supervisor by virtue of superior performance of the group. The over-all result of leadership ability in responsible positions is thus the capacity to perpetuate and multiply leadership by hiring and developing people with these characteristics.

It is my belief that change is essential to the health and vigor of any research organization. No research department should ever be allowed to become static in terms of personnel, projects, or organization. If or when it does become static, a hardening of the arteries is bound to set in and the eventual remedy may have to be a violent shake-up. Such treatment can be avoided if continuous change is provided for and encouraged. Personnel can be encouraged to move out of research into other parts of the company with advantage to all concerned. These people disseminate a better understanding of research in other departments which cannot help but have some influence on projects. Changes in personnel and nature of work may then bring about a situation in which the organization chart no longer represents the best way of getting things done. At that point we either begin to drift into the practice of forcing people to conform to the chart or we change the chart.

This is just about where we came in, so now that we have completed the circle perhaps I can do no better than echo the sentiments I expressed at the beginning. I give you this parting shot: "Whenever the organization chart gets in the way of people who are trying to get things done—turn the spotlight on the organization chart."

The Scope of Research

FREDERICK H. FROST

This symposium is concerned with research in the pulp and paper industry, not research in general, and I have been asked to speak on the scope of that research.

I think we may profitably divide the scope of research in our industry into two phases. First the potentialities which exist and, second, the broad segments of research which as a whole constitute a balanced, effective research program. We might consider the former a horizontal proposition, the latter a vertical vector.

If we first consider the scope of research from the point of view of the potential which exists in our own field we might well obtain a perspective by considering research in other industries and if we do so we must conclude the scope of research in any particular industry may and often should differ widely from that of another industry.

Let us consider for a moment the industry concerned with the production of slate. Slate is a rock deposit of sedimentary origin with the ability to split rather easily in a well-defined cleavage plane thus making it possible to produce flat pieces of varying thickness. It has been used primarily as a

Frederick H. Frost, Research Director, S. D. Warren Co., Cumberland Mills, Me.

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However, slate is quite inert chemically and is limited in its ability to be shaped or formed or physically altered. Due to these limitations the scope of research in the slate industry has been considerably restricted and wisely so. Research pointed toward the development of new uses for slate might be productive but it is quite doubtful if an extensive general research program in the slate industry would be a justifiable undertaking.

If, however, we consider in contrast an industry whose basic raw materials are carbon, hydrogen, and oxygen the potentials for research are almost infinite. The extraordinary growth of research in the chemical industry and the growth of the industry itself give adequate testimony to substantiate that point.

We see, therefore, that the scope of research is intimately and directly tied into the versatility and adaptability of the basic raw materials available to the industry in question.

What of our own industry? Regardless of whether we consider pulp or paper I believe the same conclusions will be reached so let's restrict this part of our discussion to paper. Paper, I think we will agree, is the lowest priced, mass produced flexible film. Paper is a film which can be altered to perform a multitude of different functions. Here is a sheet of paper which carries a printed message which represents one of the primary uses of paper. However, this second example is a sheet of paper which printed the message on the first sheet. It is a paper printing plate. This third sheet of paper, on the other hand, also carries a message but not printed in type or pictures, for this sheet of paper carries a magnetic coating which will record the human voice or music. As our next illustration we have a paper which has been formed into a bag and which is full of water. In contrast to that paper here is a sample of paper which can be used as a filter. Our next sample is a piece of paper which is an excellent heat reflector and is widely used as insulation whereas this particular sheet is a good conductor of electricity and is used for the transmission of telegrams.

We could go on with sample after sample of various papers each of which will serve a different function and we see from this that paper indeed has a wonderful versatility, and it is because of this basic fact that today, at least, we see no real limit in the scope of research in the pulp and paper industry. Horizons are unlimited.

We must always remember, however, that unlimited scope in an industry as a whole definitely does not mean unlimited scope for a particular company which is a part of that industry.

Research in a specific company must be limited to the development of processes or products that are useful to that company, the funds available for expansion, the extent and nature of the sales organization, the availability of raw materials, the geographical location, and other similar factors all must be considered in the policy decisions which should define the scope of research in your company and mine.

Too much research resulting in products which cannot be competitively produced and profitably sold, however good they may be, is just as illogical and dangerous as too little research which may lead to a steadily declining company activity. Research should be, first, insurance against contraction of a company's activities and, second, an assurance of expansion.

These are the reasons why it is generally considered good policy for research to be closely associated with the president's office so that research policies can be meshed harmoniously with basic company policies.

So far in this discussion we have examined the horizontal scope of research and we have seen that paper because of its versatility gives such a wide scope in this dimension that we cannot visualize any boundaries. We need have no fear of a lack of opportunities when we think on an industry wide level. Limitations will be defined by the configuration of individual companies.

Let us now consider the vertical dimension of research and what phases of research in general should be our concern.

The foundation of that dimension and the basis of all of our programs is the type of research which has largely been carried out in the past in our colleges, universities, and endowed institutions. It is research designed to discover the basic nature of substances and the interrelations which exist or can exist between substances. This research is a search for truth without any regard for practical application. It is commonly called pure or fundamental research.

Fundamental research is assuredly the foundation upon which applied research in the pulp and paper industry is based. If we did not know the chemical nature of substances and if we did not understand or comprehend the physical and chemical laws which predict the behavior between substances applied research would be a poor process indeed. We might discover a cause and effect but we would have no real comprehension or explanation of the reason why a cause produced a particular effect. Without a fundamental background of the knowledge which pure research has given us we would be operating in a half light, and applied research, if it existed at all, would certainly not have reached the prominence which it enjoys today.

These, I think, are obvious truths, possibly so obvious that we tend to overlook the importance of the enormous amount of pure research which has been made available to us as our primary tool. This being the case it is wholly logical that we should be intimately concerned with the condition and excellence of those tools.

In recent years much of the funds which have been granted to universities for research have come from government; the result of political action. This has inevitably led to a shift in emphasis in our universities from fundamental research to applied research. The politician is anxious to report to his constituents that appropriations which he has voted for and favored have produced results which have been of concrete benefit to his constituents. Even though the concrete benefits of fundamental work, in the long run, are of greater importance than the benefits of practical research or applied research it is very difficult for a politician to establish this point with people unfamiliar with research in general.

This shift in emphasis should be cause for concern. It has led to an examination of the relationship between fundamental and applied research, especially in late years, and many able thinkers have pointed out that the treasure chest of basic information is not being replenished at a rate which will continue to support the degree of magnitude of applied research which we are undertaking in this country.

I recently had the opportunity to spend several days with the director of research of an industrial concern located in Germany and to acquire some information concerning their research effort. The concern that I refer to is engaged in a business closely allied to the paper industry. Their philosophy of research is quite different from what we find normally exists in an American industrial concern of comparable size. In this particular case the company has an annual sales volume of 100,000,000 marks. Two per cent of this sales volume is set aside for research, 2,000,000 marks. Half of that research fund is devoted to applied research but the other half is spent in pure research much of which has no immediately apparent relationship to the activities of that concern. This concern obviously believes that if applied research is to be effective it must constantly be nursed by new discoveries in pure science. It is my belief that the world-wide power and influence which the German people have been able to exert is primarily due to their understanding of the relation-

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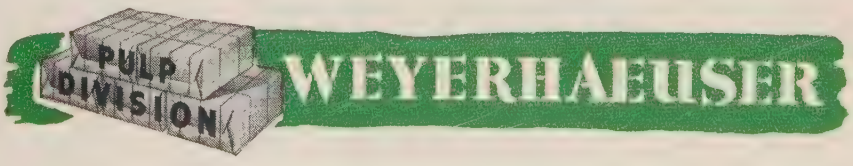
As early as 1911, Weyerhaeuser Timber Company had plans to consolidate and hold large blocks of timber land for the growing of future timber crops. In 1924, the company employed experienced foresters to work out the details of these plans.

During the mid-thirties the development of a broad forestry policy proceeded at an increased pace. In 1941, the Clemons tree farm was established as the first of its kind. Thus began a nation-wide movement which recognized the fact that private owners of forest land could and must manage their lands for continuous production of forest crops according to sound forestry principles. Now, there are over 25,000,000 acres of such farms located in 35 different states.

Today, all of the Weyerhaeuser Timber Company's operating forest lands are divided into eleven tree farms containing over 2,500,000 acres of timber land. With a background of half a century in the timber business, Weyerhaeuser is now projecting its sustained yield forestry policy 100 years ahead! This is part of the company's *permanent production program* designed to provide a continuing and *increasing* timber supply for its mills.



ship between pure science and applied science and that they have been much more practical and realistic in their thinking than we have in this country.

Pure research is concerned with the discovery of scientific facts and relationships or laws. There are many such facts which we in the pulp and paper industry need to comprehend in detail—not in order to produce or manufacture paper but in order to increase the productivity of our applied research.

We may not be actively concerned with every development in pure research but we are, or should be, intimately concerned with certain particular developments in pure science.

If we consider papermaking, coating of paper, and printing we are dealing with three processes that are broadly dependent upon adhension and cohension.

What do we know of the fundamentals of cohesion in respect to fiber-to-fiber bonding? Of adhesion between coating and body stock? Of cohesion within a coating? Of adhesion between ink and paper?

We certainly know more today than we did 20 years ago but our knowledge of the basic principles which underlie these questions is certainly not extensive and yet these *are* questions that are of concern to all of us, problems which if better understood would be of benefit to all, and principles which are of a general fundamental research nature.

Thus we see that there are particular areas in pure science that are of deep importance to us, to each of us, and that we, as a group, would be negligent in our understanding of the scope of research as it applies to our own industry if we fail to properly evaluate the importance of such broad problems.

It does not appear logical or frugal to me that each of us should individually be faced with setting up and carrying out programs of fundamental research to uncover such broad facts. It should not be a question of intercompany competition.

If that estimation is correct the logical answer is that we should undertake such research on a cooperative basis and thus, indirectly, include pure research as a part of our individual programs.

Personally I believe this question of organizing a sound program of cooperative pure research in such specific areas is the most serious problem we of the pulp and paper industry face.

I think we will be remiss in our responsibilities if we fail to establish and to finance a real and substantial program of basic research on some of the most fundamental problems of our industry. We will be remiss in our responsibilities if we fail to sponsor and finance such a program and to bring into such a program funds from organizations closely allied to TAPPI. Surely if anyone is to take the leadership in seeing to it that our treasure chest of basic information is kept adequately filled, it should be the Technical Association of the Pulp and Paper Industry.

I think this is the most important single undertaking that we as a group must sponsor. I only wish that I could be wise enough and eloquent enough to persuade each of you that you as an individual have a real responsibility to see to it that TAPPI organizes such a program and puts it on a continuing basis, finances it with adequate funds, and sees to it that such a program is guided by a trained full-time research director.

That I feel sure is the greatest challenge this organization faces today. It is a challenge I hope this group will face and will solve. It is an area of research we must not neglect.

The discussion so far has been concerned with problems which are of concern to each one of us and should be within the scope of our over-all research thinking and can well be carried out as a combined effort.

On the other hand such a program will not fulfill all our specific needs for fundamental research and we must as individual companies, if we are to progress as we should, undertake individually certain basic problems in pure science.

Let me give an illustration. Some time ago there originated within our laboratory an idea for a paper possessing new characteristics and it was immediately obvious that if such a paper could be produced it could be sold widely and would meet a real need not now adequately served by paper.

Numerous conferences were held as to how such a paper might be produced and seven concrete suggestions were made. A preliminary survey was made of these seven possible approaches and in each case it was discovered that each of these seven propositions involved chemical principles which had not been explored to any great extent and as a result were little understood. The application of any one of these principles appeared to be impossible unless more basic or pure research was done to more clearly define the principles involved.

We simply did not possess sufficient tools to make such an applied research study practical. If we decide to undertake such a development we must first sponsor a fundamental study of the *modus operandi* involved. Since the problem is not of industry wide scope but of interest to us, we as a company, must sponsor that fundamental work.

How much of this type of research can be undertaken or sponsored by small concerns I do not know. I believe it is a matter which we will have to determine by experience, by trial and error. I think it is an important part of the scope of our research and in 10 or 20 years we will find a larger and larger part of our research budgets being devoted to such studies.

If fundamental information comprises the tools which we use in working out the answers to a problem in applied research it is ideas which are the seeds from which all problems in industrial research originate.

The origination of ideas and good ones is part and parcel of the applied research program. Without such ideas we do not have research programs. Idea formulation is the second area in the over-all scope of research which will bear inspection.

If we look back over the last 50 years we see that the major changes which have occurred in our industry have not been great in number and the developments which have occurred have been generated by a relatively few ideas. Our idea fertility has not been high.

Let us examine for a moment one of these outstanding developments and see what part ideas played in the development.

Uncoated paper, for example, is being supplanted in large part today by papers which are coated on the paper machine. This represents a major change in one segment of our industry. What ideas have made this development possible? I believe there were three such ideas.

First the idea for combining the papermaking and coating operation must have been germinated. I suspect that the idea of coating on the paper machine is very old. By coating I mean laying down a mineral layer which buries the fibers under a surface, not impregnating nor surface filling.

In looking over the proceedings of the Cumberland Institute of Paper Perfection I note that at a meeting held on Jan. 24, 1913, H. A. Craigie asked the following question: "I wonder whether the method of making and coating paper at the same time has ever been tried to any great extent, that is, coating it on the paper machine." I suspect that this same question was raised by many individuals early in the twentieth century; whether or not the early application of pigment and adhesive slurries on the paper machine in England about 1900 produced a coated or a semicoated surface I do not know.

Once the idea of doing it was conceived and the advantages of such a successful development appreciated, two more ideas were essential to insure the eventual success of such a project.

Obviously combining the papermaking operation with festoon and/or floater drying would be an impractical combination. It was necessary that the idea that a coating, if laid down from high enough solids, could be immediately contacted with a drying surface without danger of marring the freshly applied film needed to be appreciated.

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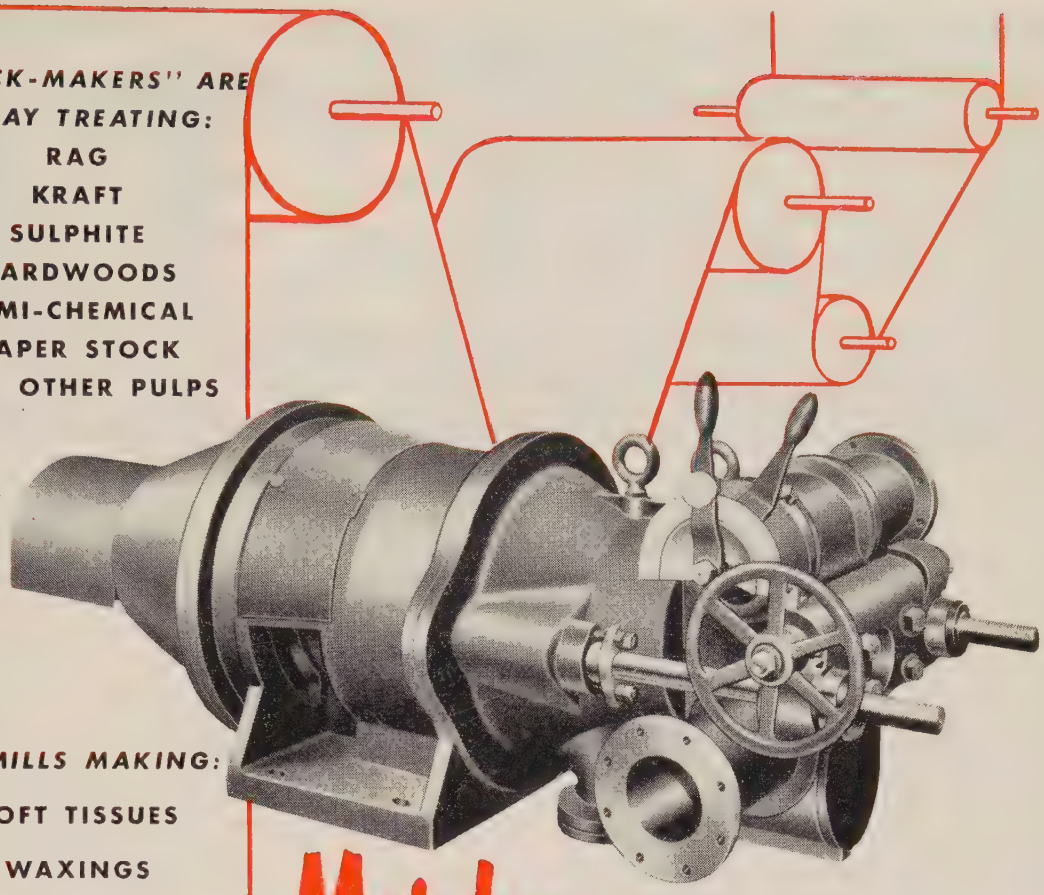

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To accomplish this a concept for the design of a coating machine, which could be conveniently combined with the paper machine, and which could lay down a coating film from high solids of adequate smoothness and uniform weight, was the third essential idea.

Once these three ideas had been conceived the development of coating on the paper machine was inevitable. It took longer to originate these ideas than to develop the ideas into a practical reality. Research accomplishments, barring accidents, are not produced without an idea as their point of origination.

As I have stated it is my belief that the research laboratory itself must assume the responsibility for the origination of ideas. It is my further conviction that the mechanism by which ideas arise has been generally grossly neglected.

It seems certain that ideas arise as a result of a particular type or types of stimulation. You will find in the literature on research procedures some discussion of what type of circumstances lead to ideas, but how many of the young men whom you employ to work in your own research laboratory have ever attended a course during their formal training which was designed to explain to them how ideas originate and how they can make their minds more fruitful in the production of ideas? As a result of this lack, how much of their latent talent has been undeveloped? I do not know but I think this may be the second most important point that has generally been overlooked. It is my opinion if we had set out deliberately 20 years ago to discover the stimuli that leads to ideas, and had trained our research personnel to properly expose themselves to such stimuli, our industry today, in 1953, would have been far in advance of its present position.

Personally I do not know whether or not a study as to how ideas originate can be or should be undertaken by TAPPI.

Research to discover the underlying principles which stimulate originality in thinking might be beyond the scope of TAPPI but, on the other hand, it might be profitable for TAPPI to assemble the known available information and to publish a monograph on this vital and most intriguing matter.

The third phase of our over-all research program is the task of converting an idea into a successful product, process, or into a new use for an old established product. This is strictly applied research in the narrow sense.

Obviously ideas must be screened. The good must be separated from the bad. The end result, if accomplished, must be a desirable result for the company involved. We must be sure we stay within the area of basic company policy. We must know when to push a project forward, when to retreat.

We must have adequate tools, esprit de corps within our organization, a variety of talent, means for creating new tools and pilot machines, and individuals with initiative, judgment, and background—in short, an alert, balanced organization properly housed and equipped.

There is no question where this work starts—always with an idea—but the question of where this third and last phase of our effort should end is a question which will draw a diversity of opinion.

Bichowsky in his book "Industrial Research" argues that research is the antithesis of engineering. He suggests that a proper motto to hang over the door of the engineering department is "Nothing shall pass this door which is not fully considered, fully tested, and of which there can be no possible doubt." He goes on to say "Such a professional attitude is fatal to research and engineering should never be given the last word in a research decision."

If this estimation of the situation is correct, and I believe it is generally considered so, we have no emulsifying agent which will harmoniously mix research and engineering.

It follows that research stops at a point where engineering begins—that we keep these two functions separate and distinct.

Suppose, for example, we have an idea for a new type of coating process. The idea may have many facets—several approaches that need evaluation and testing.

In order to test these various possibilities we in research plan a machine to test these possible subideas. After considerable cogitation, false starts, and preliminary drawings we finally agree on the design of a pilot machine which we believe will make it possible to separate the conflicting opinions by tests and obtain the necessary information engineering will need to design a practical machine that will work.

If you take the design of this machine to the chief engineer and ask him what he thinks about it he will, if he is a good engineer, either hit the ceiling immediately or after you leave call the mill manager and tell him the research laboratory has designed the darndest, most impossible contraption he has ever seen and it will never work in production. He is being true to his motto and absolutely correct. Of course the machine is a monstrosity; of course it is not an operating design—it is a research tool designed to produce nothing but information—the essential information which engineering must have to design a practical production coater—one that will work.

Thus we see the two basic viewpoints are in conflict and this illustrates the need of carefully defining the research end point of a project. Our research should stop at the door of engineering—if we mix the two under a single head we mix our habits of thought, our habits of approach, or points of view, and the resulting offspring will not exhibit hybrid vigor.

If you accept this end point for your over-all research program we have covered the scope of that research.

Mr. Kettering points out, "The human family in industry is

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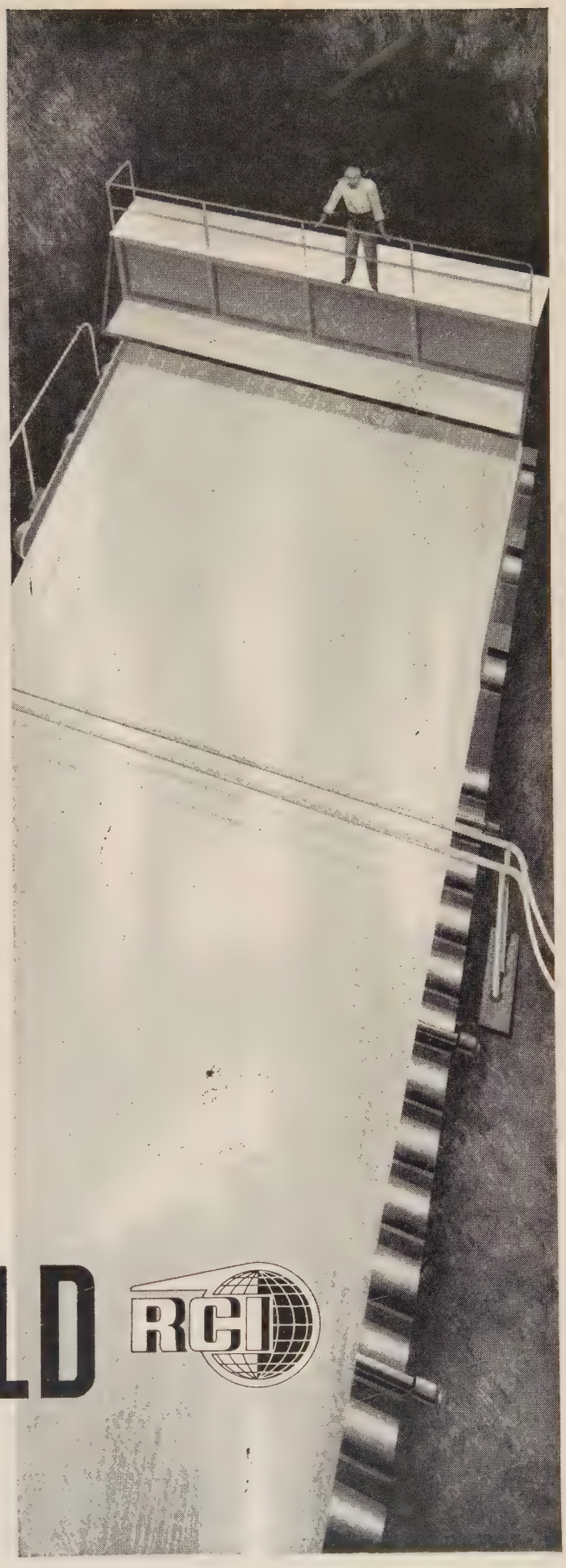


always looking for a park bench along the road of progress where it can sit down and rest but the only park benches I know of are immediately in front of the undertaker's shop."

Park benches are not a part of the scope of research but I am sure all of us, when our spirits are temporarily low, have been frustrated by the thought that at the successful conclusion of a tough problem there is no rest in sight—only a tougher, knottier problem with a request for an answer tomorrow or even sooner.

That is a human reaction but is no excuse for cluttering a research laboratory with park benches. It is easy to do—just put quality control under research and it becomes possible to occupy yourself with routine testing which can be almost done with muscular memory—the brain muscle not included. To me such work should be excluded from the scope of research because of the temptations which may be involved—certainly it *need* not be a part of research.

In summary I see the pulp and paper industry as a field of unlimited potential for research and I believe the three basic divisions—pure research, idea production, and applied research—all come within the scope of a research program in an alive, vigorous, and growing concern.

The Stimulation of Research

WENDELL W. MOYER

This subject presented as a section of a symposium on the management of research implies three assumptions. The first is that research activity can be stimulated by persons having the opportunity to act as stimulators. The second is that such stimulation as can be applied is desirable. The third is that stimulation is effective in increasing the productivity of research. These assumptions seem reasonable, but before we accept them without reservation we should review the kinds of stimuli that are generally acceptable to research men as well as to those in authority. It is well to exercise the faculty of judgment in dealing with matters of psychological nature.

The basic consideration to keep in mind at all times is that of achieving optimum results from a research organization. The goal of optimum results is not a discrete target because, so far as I have been able to determine, no yardstick has been devised to measure the efficiency of creative work. This is particularly true of industrial research where an investigator is limited to an area between the walls of natural and economic laws. However, we can pick out a number of industrial research laboratories and say that they have been outstandingly successful because their companies have grown and prospered as a consequence of useful discoveries and inventions that originated directly from research. Unfortunately, we can find a few research laboratories that have been comparatively sterile, that have not yielded adequate returns for the money expended. In between, there are many laboratories that have achieved varying degrees of productivity. Many reasons can be set forth for differences in research success, but we can speculate that stimulation, positive or negative, has much to do with the variations in performance.

It is beyond the scope of this discussion to touch upon all the factors that contribute to research productivity. I could by a twist of rhetoric classify all the factors as stimuli and not digress too far from reality. Every condition in the research environment, whether it be physical, intellectual, or emotional elicits a response from the research personnel, and thus could be termed a stimulus. To keep in bounds, I shall bring up primarily the psychological factors that relate to the motivations of human beings. Research scientists do not have refrigerated circulatory systems and do not react with cold-blooded objectivity to the influences that sway the rest of the human race. We should be thankful that this is true.

A stimulus is an action that incites a response. The response may be evaluated as good or bad, desirable or undesirable, depending upon the point of observation. I am not going to dwell on stimuli to research from the undesirable or negative side, but there is one powerful stimulus which should be mentioned because it is destructive to the principle of optimum results. It can be called threatening force. In a crude form it is exemplified by the ultimatum: "Johnny, get that job done by the first of July or look for another job." Johnny will respond to this stimulus in various ways, one of which may be to engage in a furious spurt of activity that will give a feeling of satisfaction to the stimulator. But this frantic activity provides no insurance that the job will be concluded successfully by the first of July.

Forcing techniques may be applied to the indolent or careless who are working on routine assignments that do not require creativeness. But force and the overt or subconscious rebellions that it engenders are not conducive to the calm reflection needed by the mind to produce its higher creations. Research results cannot be ordered into being. This principle is recognized even behind the Iron Curtain where captive scientists are provided with more of the symbols of freedom than most of their native associates.

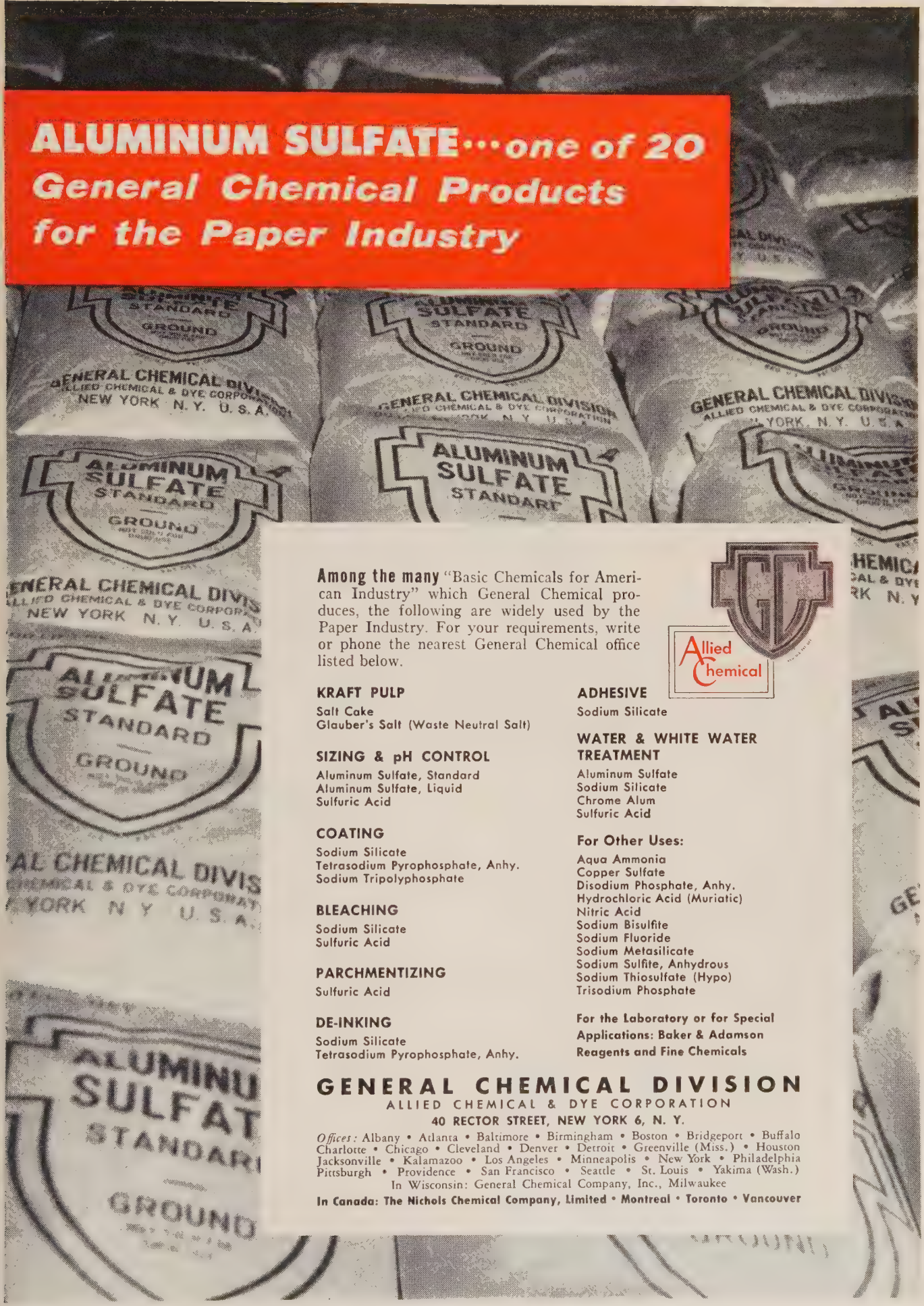
If we are sensitive to the basic urges that motivate us and all human beings, we cannot but understand the incentives that lead research men to creative productivity. We want to find a satisfying personal status, we want to feel important, we want to "belong," we want to communicate, we want to inquire, we want to venture, we want to achieve. Young men who take up a scientific career in research are unusually endowed with the urge to inquire, to think, to venture into the unknown beyond the frontier of existing knowledge, and to achieve something that can be integrated with a feeling of personal accomplishment. The thrill of a useful new discovery or the birth of a new idea transcends for a time the pleasures of any subsequent rewards. The flame of creativeness does not burn steadily, and it cannot be extinguished too many times ere long it cannot be relit. The purpose of any type of stimulation to research is to keep creativeness alive and glowing. A lesser purpose is an artifice of limited effectiveness.

The most powerful stimuli to successful research proceed from top management. The sincere and participating interest of the group in control of the destiny of a company is vital for optimum results. Much more is involved than being generous with funds for research, furnishing the ultimate in modern buildings, and giving wide publicity to the research activities. What is needed is the conviction that the maintenance and growth of the company in a competitive, technically evolving age requires the services which only organized research can perform, and the acceptance of research as a partner in the business alongside of production, sales, finance, and other major functions. When this condition exists the men in research feel that they "belong." Their immediate and narrower scientific interests are expanded beyond the walls of the laboratory to the broader vistas of service and growth of the company.

Such remarks as the foregoing appear trite among people who are associated with companies that owe their origin and progress to research. But there remain many companies that have adopted research at a later period in their development and are still waiting hopefully for the miracles of research to happen. The managements are at a loss to comprehend why more profitable results do not come from the large staffs in the scenic buildings.

Contrary to popular opinion, research men in industry do not like the idea of being confined in ivory towers. Isolation is forced upon them, it is not of their choosing. In some quarters research men are called "long-hairs" and "prima donnas"

Wendell W. Moyer, Director of Research, Central Research Dept., Crown Zellerbach Corp., Camas, Wash.



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under the impression that they have lost contact with practicality among their complicated gadgets and glassware. They work for months and years, it is alleged, on some simple job that someone with common sense could have done within a few weeks. Keep them in the laboratory where they won't cause trouble!

So long as this is done, they don't cause trouble. Also they don't cause profits. The barriers to research progress can be readily torn down by the sincere interest of top management. Misconceptions fly away like chaff in the wind when management really wants to use research to the fullest extent. Only from detachment arise the misunderstandings of what research is, of how it operates, of its limitations and potentialities. The stimulation of a profound interest by management rapidly penetrates through an organization to every research man at his bench or desk, and to the people in other divisions of the company with whom research men must cooperate in concerted team effort.

The attaining of optimum benefits from research demands that top management also take responsibility broadly for the direction of research efforts. Every company has its own practices, policies, and long-term goals. Unless the research men are informed of the principles that comprise the philosophy of the company, they can hardly be expected to direct their activities in parallel paths. A research project that is aimed in a counter or cross direction must be judged as futile effort because, even though successful, it will be marked for future consideration and entombed in the files. Research men need the stimulus of management counsel to aid them in harmonizing the objectives of research with the broadest objectives of the company.

A question can arise at this point: do research men resent direction of their affairs by laymen, regardless of their positions of authority? My own observation is that resentment is stirred up in scientists on that score in only one way, and that is when they are told how to solve their problems. Interference in matters that require advance scientific knowledge and skills is certainly a negative-acting stimulus and can counteract the benefits of helpful counsel. Otherwise, I can state that research men are eager to obtain advice from any source that can supply it. They know that it is their duty to offer advice to management in the form of recommendations of action to be taken on research projects, and hence welcome an exchange that signifies cooperation.

After top management has torn down the ivory towers built around research by cool detachment and has accepted research into highest councils of the company, there remains still a major responsibility to be discharged. The results of research must be put to work. The million-dollar discoveries in the research laboratory do not yield a return until they are put into productive use. For anyone who has felt, figuratively, the moist breath of the sales department on the back of his neck while completing the development of a new product, no problem may seem to exist here. However, in such a case you will frequently find that existing production equipment can be used for the manufacture of the new product and a ready market is waiting.

Putting research to work costs money, and sometimes big money, the control of financial outlays is a management responsibility. Admittedly, the uncertainty of research makes it difficult for management to budget the funds required to finance the favorable results of research. One year the research department may seem to be completely inept, and the next it may erupt with a dazzling display of valuable inventions. The erratic behavior of the research process is not a critical factor as it affects the stimulation of the process. There are methods of control that do not affect the psychological environment too seriously. We are concerned here with the stimulating effects that are experienced by research men when they see the creations of their minds and hands put into useful service.

No single force so vitalizes a research laboratory as the starting of a flow of research results into production and sales. The open secret of an energetic, inspired, and productive research organization is the dependable knowledge that management will utilize as rapidly as possible every significant contribution the men make. Beyond any success the company enjoys through the utilization of research results, is the realization of personal goals by the research men in pride of achievement, increased remuneration, promotions, and opportunities for new discoveries.

The top man in a research organization, whatever his title may be, has also many obligations if he is to act as a source of desirable stimuli to the research activity that he manages. His own scientific training should make him cognizant of the the many problems peculiar to organized research. He should be sensitive to the emotional currents that accelerate or dam the flow of work. He must remember that his attitudes are often magnified out of proportion to his intents.

One of the most powerful motivations within a human being is the desire for freedom. Freedom in any absolute sense is a utopian dream, yet all of us treasure feelings of freedom in certain areas even though we know that we are surrounded by necessary restrictions. More than in any other human endeavor, creative work demands an environment of freedom in which to thrive. In the ideal research department every member would have a sense of freedom to think, to venture, and to create, unaffected by the restrictions of organization and limitations of funds.

The head of a research department can do much to foster a sense of freedom without reliance upon personal magnetism which more than likely he does not possess. One of the simplest and obvious means is to delegate authority, that is, if he does not forget the corollary that delegation of authority also means delegation of credit. An assured method for destroying the sense of freedom and drying up the wells of inspiration is to give a man the responsibility of doing a job and then to take from him the glory of accomplishment.

If research projects were all one-man assignments requiring the application of one set of scientific skills, the administration of research in an ideal manner could be more nearly approximated. A major project, however, usually demands the specialized knowledge of several branches of science and engineering to bring it to a satisfactory conclusion. The services of many men are ofttimes required, working simultaneously on different phases, or in a tandem relationship. Thus the modern research department employs research teams to effectively solve problems. Group participation provides a wholesome stimulation to creative accomplishment, provided that each man in the group is allowed to feel that his contribution is an integral part of the whole. While creative thought is an individual effort, each man in an active project team can stimulate the flow of thoughts within his teammates, and in turn be stimulated by their thinking.

A stimulus cannot incite a reaction unless it can impart energy through some channel of transmission. All transactions among human beings are effected through communications. All the stimuli of research that I have mentioned require channels of communication in order to be effective. Unblocked lines must be opened from the research bench to president's desk. The lines may pass through several switchboards, so to speak, but the switchboard operators should be trained to receive and transmit messages in both directions without distortion.

If by communication we think merely of the routine procedures that exist in every laboratory for the transmission of letters, memos, orders, reports, notices, and factual data of all kinds, then we are missing the stimulative potentialities of communication in the broadest sense. A free interchange of ideas among the research men multiplies the probability factors for the successful solutions to problems. In a large laboratory it is not possible for each man to know the details of the problems of all the other members. But by the judicious

whys?

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use of staff meetings, seminars, intergroup meetings, parties, and dinners, it is possible to acquaint everyone with the methods of attack and the objectives of the major research projects. The old German system that prohibited two men working in the same room from telling each other what they are doing is vanishing.

Each research man has the opportunity to do unique things that he identifies with his own intelligence and skill. He may solely, or in part, be responsible for a major money-making development, or he may discover a new fundamental principle of nature of no immediate commercial value, or he may devise a new technique or instrument of wide utility in some branch of science.

As I indicated earlier, any individual achievement is a powerful stimulating tonic to the creator. He may not run through the laboratories yelling "Eureka" but he will feel like expressing himself in some way. He has the basic urge to communicate, and we must not ignore this if the optimum value of such stimulation is to be utilized. Research men must be provided with the opportunity to communicate their creative achievements to others through the media of personal presentation of papers at scientific meetings, of national as well as local scope, and the publication of articles in appropriate scientific journals.

Industrial research men realize that the company which employs them has first rights to the fruits of their work, and do not object to a time lag in reporting while the company obtains sound patent protection or a head-start in use. A general policy that prohibits, or discourages, research men from communicating is short-sighted. A wiser policy is to give in order to receive.

Creativeness can be stimulated by communication beyond the laboratory and company. Research men should be given frequent opportunity to exchange thoughts with other scientists at professional meetings. While useful information is presented in papers at the formal sessions, I believe that the dollars-and-cents ideas that we pick up at meetings more often than not are generated by having our thoughts extended beyond their usual confines by stimulating associations with people who have similar interests. Also the greatest value we receive from a program paper often comes from projecting our imaginations beyond the limits of the author's investigation. Research men should also be given the opportunity to visit plants, laboratories, and universities. Contacts with other divisions of their company and with customers are further reliable sources of inspiration.

Not all communication is on the verbal level. As a stimulus to productive research, the communication of emotion (for lack of a better word) is of greatest significance. Emotions vibrate through an organization pervasively. Communication is rapid. It can't be directed, created, or destroyed; it exists. It is the mechanism by which the various stimuli we are discussing become effective. This is an intangible concept, not subject to objective proof. Yet were it not true in part, such words as sincerity, vision, freedom, and aspiration would be meaningless. Each research laboratory communicates strong impressions to a visitor who can construct, if he wishes, a remarkably accurate picture of the productive pattern of the laboratory.

The thesis of this paper is that the optimum results of research are attained by the stimulation of the creativeness of research men. We usually attribute individual creativeness to an inherent characteristic of the mind related to imagination. We tend to plan more in terms of hiring the men with creative ability than in developing latent potentialities. We accept the lack of creativeness or inventiveness, to use another term, as a natural condition. Yet in what way does creative thought differ from analytical thought?

Friedrich Schiller, the great poet-philosopher once wrote: "In the case of a creative mind, it seems to me, the intellect has withdrawn its watchers from the gates, and ideas rush in pell-mell, and only then does it review and inspect the multitude." Here is the secret of creative thinking and a formula for teaching it. This method of thinking is in opposition to the one that we are led to adopt in our training in science and the scientific method. We fear being accused of slipshod thinking if we do not examine and analyze for soundness every idea that comes in our head. The superior method is to let all the ideas rush out without criticism and then "inspect the multitude." Research men enjoy and profit by exercises in this method of thinking.

I have dwelt on the stimulation that can be imparted by top management and the research director, almost implying that the research man at the bench is the willing or unwilling target of directed stimulations of all kinds. I want to emphasize that stimulation does not travel a one-way street. Each research man can exert a powerful stimulation to his supervisors all the way up the organization chart. If he is good, an effective stimulator, the time is not too removed in the future when he will be exerting the greater percentage of his stimulatory power downwards.

Organized industrial research is the most effective process devised by mankind for creating new things. It has been developed at this midpoint of the 20th Century to a condition of productivity that appears amazing to the general public. We can attribute the success to date, chiefly to our understanding of how to apply the incredible power of the scientific method to the solving of problems.

Yes, we can be proud of what our research process has done, but I do not want to conclude with an air of complacency. I want to ask a disturbing question and give you my answer to it.

How efficient, in an engineering sense, is our research process and what can we do to increase the efficiency?

I believe that the efficiency of today's research is far below optimum, in fact, less than 50%. That is, at least one half of our scientific man power is expended in futile, wasteful energy losses.

What can we do about it? In the first place, recognize that research is a human activity that is subject to all the influences that affect human beings.

Secondly, implement the scientific method by sound principles of human engineering directed toward the stimulation of our dormant creative powers—a great unexploited natural resource.

Selling Research to Management and to Labor

MILTON O. SCHUR

When asked to discuss the subject of selling research to management and to labor, I was taken aback, for I have never consciously spent more than a small fraction of my time attempting to sell research. Rather I have been content to let the results of research do the talking. It may be that I have been unusually fortunate in having always been associated with forward-looking management, alert to the essentiality of research and to its potentiality for gain. My most difficult problem with top management, it seems to me, has arisen whenever I have found it necessary to advise *against* expenditure of time and money on research or development work on unsound projects, such as are occasionally brought to every company by glib promoters or by well-disguised crackpots. But it has been insisted that since I have actively directed or managed research for many years, it follows that I know considerable about the recondite art of selling it. I must say in self-defense, however, that if my presence before

M. O. Schur, Manager of Research and Development, Ecusta Paper Corp., Pisgah Forest, N. C.

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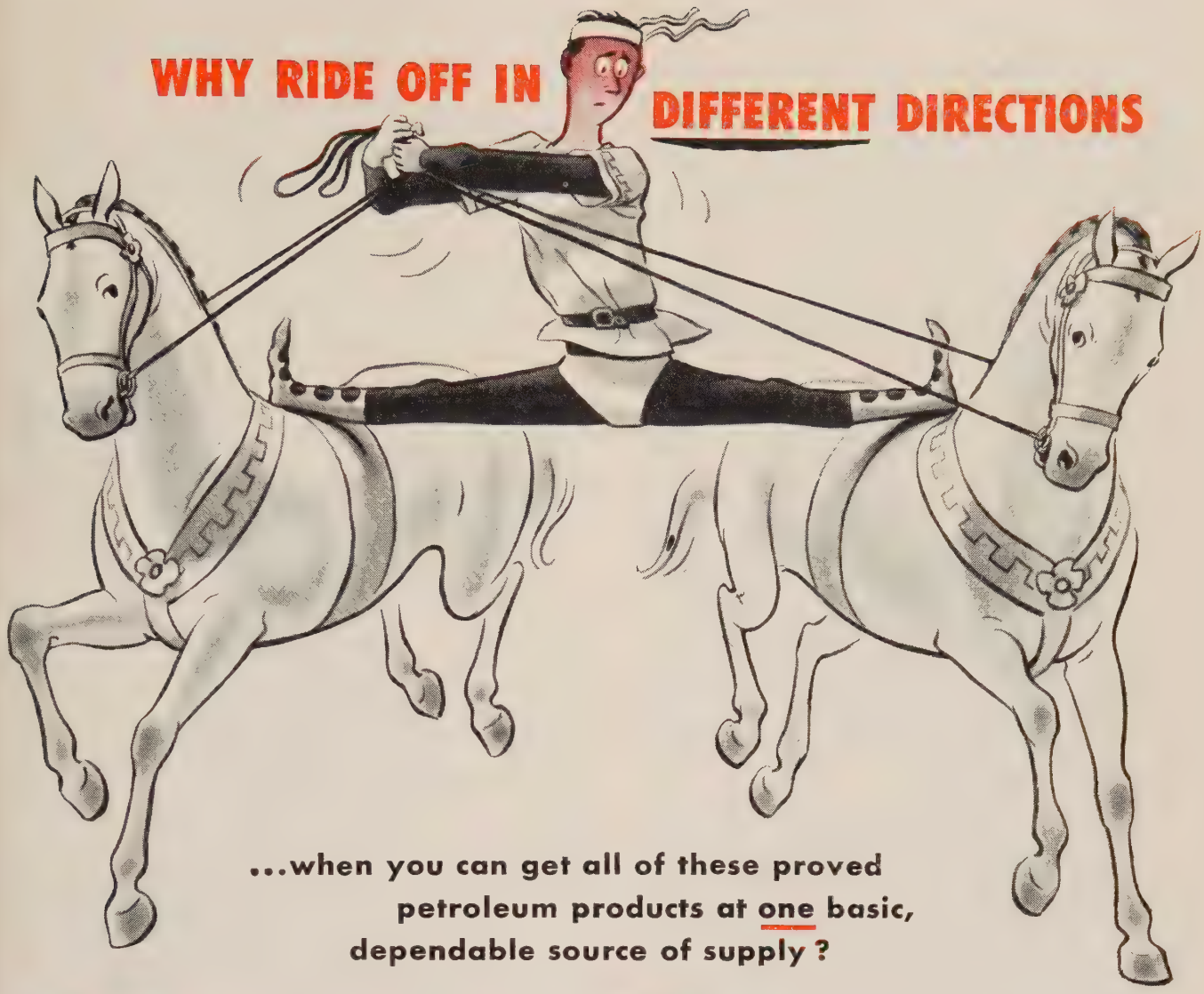

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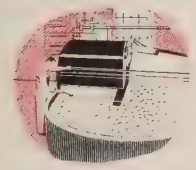

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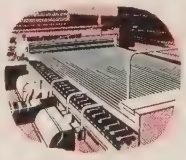

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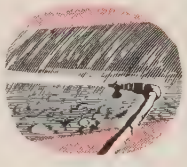

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you implies anything at all, it is that the chairman is a better salesman than I am.

However, in the regular course of my work, I have indeed devoted much time and thought to the preparation of research programs, budgets, and annual or semiannual reports. In dealing with different types of management over widely varying times, I have learned that this phase of selling research to management necessitates the consideration of a multiplicity of factors, thus, the extent to which the company is already engaged in organized research, whether it is dominated by the sales, the financial, the legal, the production, or the research department, whether a specific project or a broad program is under consideration, the relative proportions of fundamental and applied research thought to be best suited to the enterprise, whether the index of return (*1*) is low for projects otherwise deemed to be important to the company, the extent to which management participates in ownership of the company, whether top management is local or absentee, the character of the organization chart, the age or maturity of the enterprise, the ages of its products and processes, the market standing of its products, its size, history, financial condition, the ratio of its overhead cost to total costs, its ability to obtain additional capital should such be needed to utilize the results of research, the tax situation, and so on. Circumstances vary so widely from indstry to industry, and from corporation to corporation within any one industry, that it is inadvisable to attempt to cover all situations by simple, sweeping statements. On the other hand, analysis of typical cases within the time available would be of limited applicability. As a practical compromise, I shall consider the attitude of management generally toward research, and I shall tell you of one approach to labor that has given me, and undoubtedly others, reasonably good results.

By and large, top management, directors, and stockholders are well sold on research. This is evident from the fact that during the past 20 years expenditures for research have increased in the United States more than tenfold, and are now running at the rate of about 3 billion dollars per year. James Killian, Jr., points out that this is a sum almost as large as the federal budget of 25 years ago. Today, 70,000 scientists and 55,000 engineers, or a total of 125,000 men and women, are engaged in research in this country. About 60% are in private industry, 33% in government employment, and about 7% in our universities and other nonprofit institutions. Of the 3 billion dollars going into research, about 40% is being spent by industry, 55% by government, and 5% by universities and other nonprofit institutions (*2*).

The President of Olin Industries, Inc., John M. Olin, talking to the Management Club at East Alton, Ill., a couple of years ago, said: "A business like ours carries many kinds of insurance, and I sometimes think of the money we spend on research and development as the premium on one form of insurance policy. I look upon it as a protection to our leadership in the fields in which we compete, as well as protection of our place in industry generally, by insuring that we will keep pace in the development of new products."

One might similarly point out that well-managed industry spends large sums of money for a variety of preventive purposes, for example, accident prevention, fire and explosion prevention, preventive maintenance, and the like, and that expenditures for research and development might be considered money applied for the prevention of stagnation and loss of opportunity.

Management realizes that expenditures on research and development are a defense against cheaper or better products in the hands of a competitor, which could well undermine a company otherwise having all the statistical requirements for success. Profits spent on research denote, in the language of the financial crowd, a "growth situation." Such money is reinvested earnings. It normally leads to enhancement of book and intrinsic values, and eventually to an increase in dividends. Of the hundred leading industrial organizations in the United States, all have research departments, and many have nationally advertised slogans featuring their research activities.

The development of new products and new industries based on research is being strikingly shown in New England's industrial revitalization after a drop of 6% in manufacturing jobs during the last 30 years compared with an increase of 40% in the nation's total. The man given credit by *Time* Magazine as having had most to do with New England's comeback is Laurence Whittemore, president of one of our great pulp and paper manufacturing concerns, who during the past 3 years has poured 12 million dollars into plant improvement and research (*3*).

It is common knowledge that most of our pulp and paper companies are actively engaged in research, either in their own laboratories, pilot plants, and mills, or in outside institutions. Indeed, it is likely that all of our pulp and paper mills are carrying on research of one kind or another, even those that have not yet set up formal research organizations. Research in our industry is inescapable. This fact has been clearly evident from the time the first sheet of paper was fashioned by an inventive and enterprising Chinese researcher, more than 2000 years ago.

That pioneer paper research director may have had no management or labor force to sell research to; on the other hand, he had no enthusiastic sales manager to hold in check, unless it was himself. Sales managers may become difficult when a new product is almost but not quite ready for the market. I remember well when the sales department of the organization for which I was then research director requested some years ago that I release for sale without further delay a new mine pipe, comprised of wood pulp, which my department had conceived and upon which we had been working for about a year. When I asked for 6 months' time to run tests on the pipe under service conditions in at least two coal mines, the sales manager became indignant. He wanted the product at once. But I was adamant in my insistence that the pipe needed further study before we could safely consider it a salable product. The situation was tense until the president of the corporation came to my rescue by telling the sales manager about the youngster who early in December asked his daddy for a baby sister as a Christmas present. The father, with a quick glance at his wife, explained that it would take much beyond Christmas time to provide the sister. "Well," said the little boy, who had often heard his daddy telling how *he* got things done at the plant, "Let's put more men on the job."

The sales manager and research manager must work closely together; they must understand one another's problems, and must pay respectful heed to one another's suggestions and gripes. Organization charts and formal manuals of organization procedure must not be permitted to stand in the way of direct and frequent contact between these managers. The sales manager has every reason then to be an ardent champion of the research department, for he soon learns, if he does not already know, that he can rely on the research force constantly to strive for ways of lowering costs without impairment of quality, to prospect unremittingly for quality improvements that will facilitate sales, to find new uses for his standard products and thereby new sales outlets, and to develop new products to add to the sales line.

The production manager, on the other hand, may find it more difficult to be enthusiastic about the work of the research department, since in a typical organization he, unlike the sales manager, receives at the close of every business period a charge from the main office for research. He is then torn between two conflicting desires: he wants prompt help from the research department in finding ways of cutting costs, in avoiding or in getting out of trouble, and, through the development of new products, in keeping his equipment fully

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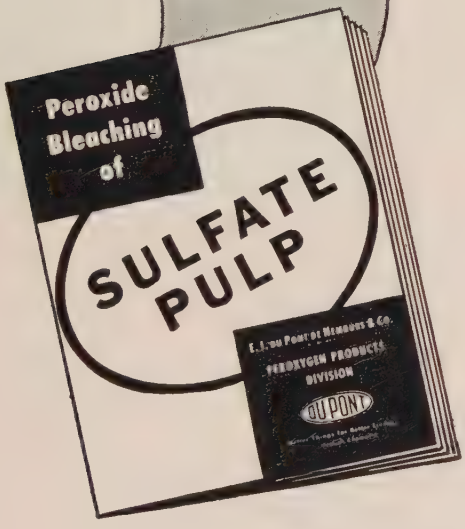

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occupied; but he is also anxious to show low production costs. Ordinarily, he is in no position to compare charges for research with the monetary value of the advantages he gains through the work of the research department, especially in connection with long range projects. As a result, his conflicting desires may develop a sort of production department schizophrenia that could raise havoc within the company. The remedy, however, is quite simple: top management should stop needling the production manager with data on cost of research, which, in the last analysis, is a budgeted item, and, like the cost of sales and of administration, is beyond the control of the production manager. Because the largest item in the expense of research is usually that of salaries, and since research men cannot be hired on short notice and should not be hastily dismissed, the monthly cost of running the research department, once it is organized, is ordinarily relatively constant until the budget is changed. Experimental mill runs may, of course, temporarily skyrocket the cost of development work, but, here again, top management does the controlling.

If, however, company policy directs, for one reason or another, that the production manager be periodically informed of the charges for research allocated to his department, and if the research manager finds, after adequate soul searching, that through no fault of his own, he is making little or no progress in selling his ideas to the production people, he has only one recourse, namely, to have the chief executive, the "mutual boss," as Rassweiler puts it, make it clear to the production manager that he wants him to "buy" research (4). How long and how visibly the spirit of the chief executive must hover over the production force to assure cooperation depends, among other factors, upon how apparent the successes of the research department are, how much good the production people feel they are gaining from these successes, and the generosity and the sincerity with which the research men acknowledge the help of the production department.

At Ecusta, our situation is somewhat unusual. The controller sends the production manager each month the allocated cost of running the research department; and the general manager has not requested the production manager to "buy" research. Yet our production manager and our general superintendent, good operators that they are, insist that a research man be present every morning at the regular superintendent's meeting; they request help without the slightest hesitation in the solving of production problems; and they feel hurt should their request for help be given less than the highest priority. Our production manager and our mill superintendents know that we take their problems to heart very seriously; that we make their problems our own; and that we never act as a police force, for when we find something wrong in the mill (what mill, like what research department, does not occasionally pull a boner?), we deal directly with the men concerned, not with top brass. They, in turn, give us freely of their time in the planning of mill runs, though they, being very human, disrelish the distractions and inconveniences associated with mill experiments; and they and their men take a lively and constructive interest in our activities.

So far as concerns labor, if labor needs to be sold on research, it is ordinarily because research implies change, and change is inconvenient, disturbing, and perhaps has a dangerous aspect to the uninformed. Labor, therefore, as soon as it comes into contact with a research project, should, in my opinion, be taken into "partnership," so to speak, by the research men, who should make clear the goal of the project, technologically and financially. If the project seeks to improve one of the mill's products, labor should be made to feel that it is participating in a show of skill or in a contest with a competitive organization; if the purpose is to reduce costs, labor should be made to understand that successful culmination of the work will make jobs more secure against the threat of lost markets; if new products are being developed, that opportunities for expansion and therefore opportunities for new and better jobs are being created. Labor should be informed of the research techniques being used and of the results being obtained. All this should be done, of course, with tact and with appropriate restraint, and through the production manager, the superintendents, and the foremen, as well as by direct contact. This is no easy task, but it is a profitable one.

Ordinarily, employees at all levels, like people generally, are interested in experiments, in new techniques, and in novel results. We are all potentially sidewalk superintendents! If employees are given the opportunity to know what is going on, their cooperation, I have found, is spontaneous, or, at least more readily assured. Of course, congenital dissidents and noncooperative individuals are wherever you find them, but since their concentration is relatively low and their identity already known to their more normal associates, they are usually little else than nuisances; and they have only transient, if any, influence on the attitude of labor generally toward research, provided the research force in contact with labor makes a real effort, in a friendly, noncondenscending, and not too obvious a manner, to arouse the interest and curiosity of labor in the research project.

In this connection, an interesting management experiment is being conducted at Pisgah Forest, where, in a series of regular meetings, department heads, including the manager of research and development, tell groups of employees at various levels of the organization how their respective departments are organized, how they function, what they are doing or attempting to do, and why. Questions are invited from the floor, and every attempt is made to answer in simple, unequivocal language. The response of the employees has been splendid, and we feel certain that our people, thus taken into our confidence, will be enthusiastic about our work, tolerant of our mistakes, and sympathetic toward our aims.

To recapitulate: the results of research have sold research to alert management as a businessman's speculation with good odds for gain; and labor can be sold on research if the research worker links arms with labor, explains what he is seeking and why, and shares with labor the excitement and satisfaction of pioneering in a field of common interest.

LITERATURE CITED

1. Furnas, C. C., "Research in Industry," pages 413–415, New York, D. Van Nostrand Co., Inc., 1948.
2. Killian, James R., Jr., *Tech. Rev.* 55, No. 1: 23 (Nov., 1952).
3. *Time*, page 87, Dec. 8, 1952.
4. Rassweiler, C. F., *Chem. Eng. News* 30, No. 2: 149 (Jan. 14, 1952).

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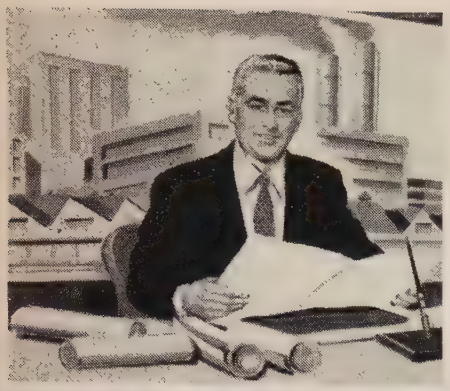

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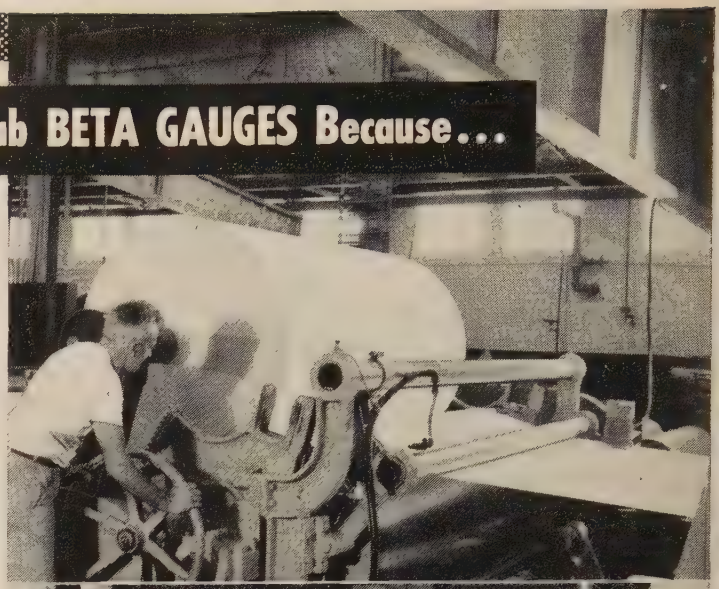

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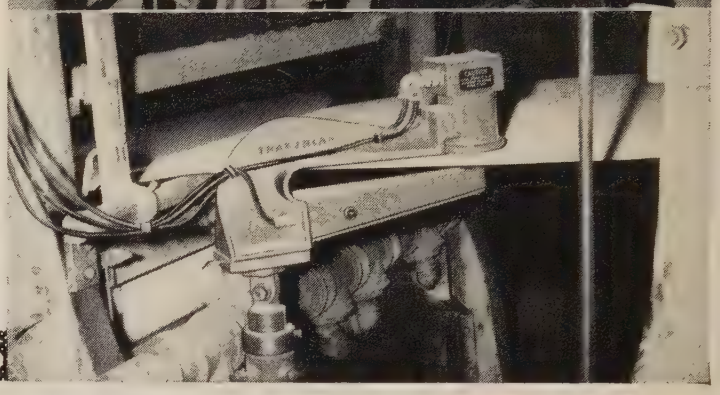

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Absorption and Backscatter Gauges $3,300

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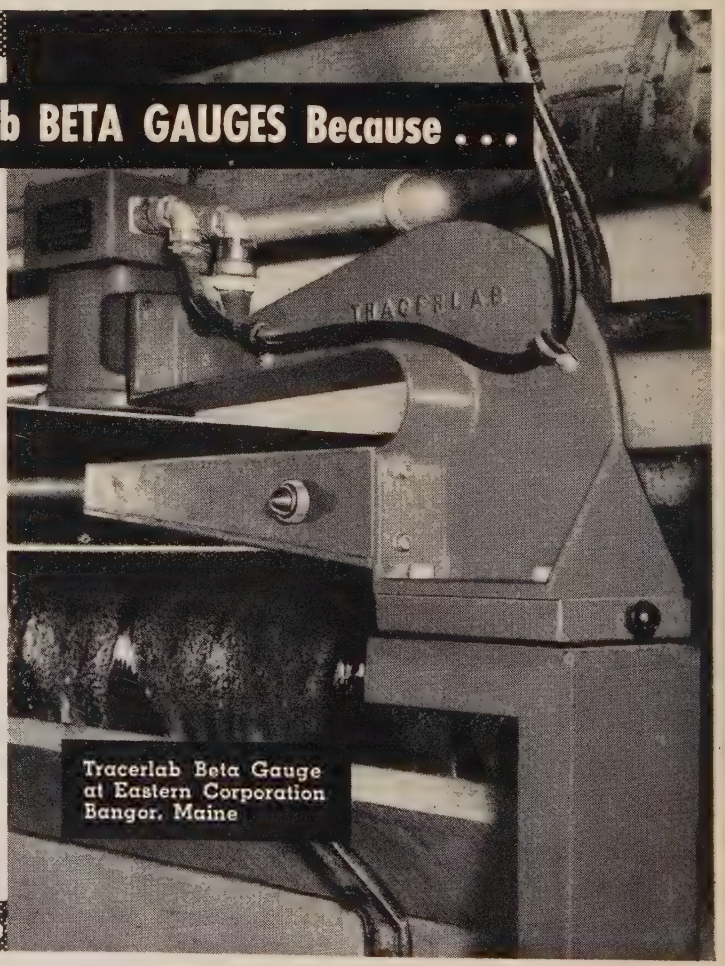
they can now "insure uniformity of weight in all runs of genuinely watermarked Atlantic Bond." If weight control is a problem in your sheet processing operation Tracerlab Beta Gauges can do the same for you.

Eastern Corp. also says, "The advantages of the Beta Gauge are many, such as: Elimination of tear-outs (or sampling), which previously were taken periodically to determine the accuracy of the weight; increased uniformity of basis weight; also increased production with resultant savings due to elimination of off-weight paper and faster weight changes. The instrument has proven to be very satisfactory and the Machine Tenders have absolute faith in it. The running weight of the sheet is constantly recorded and if any variation occurs, changes can be made immediately."

Tracerlab Beta Gauges are now cutting costs and increasing quality in many sheet processing plants . . . paper, rubber, floor and roof covering, plastic, tape, laminated products, metal foils . . . and on many special materials. Both Absorption (as shown) and Backscatter gauges, were pioneered and **first** made available to industry by Tracerlab.

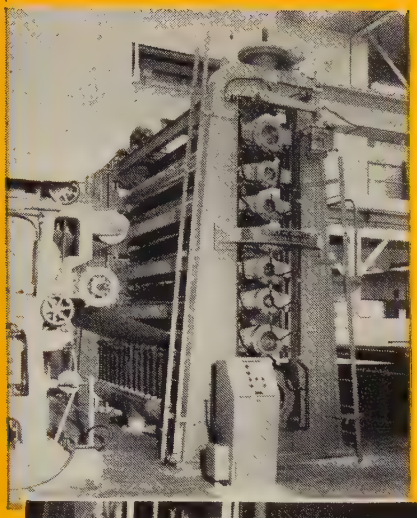
ASK for FREE booklet "Tracerlab Beta Gauges"



Tracerlab Beta Gauge at Eastern Corporation Bangor, Maine

Tracerlab®
130 HIGH ST., BOSTON, MASS.

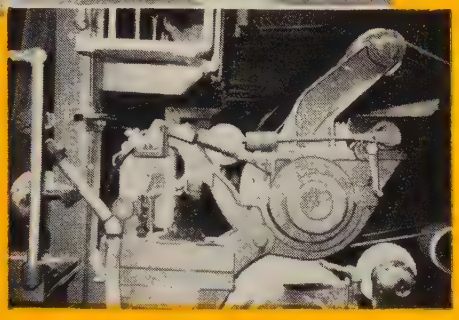
Absorption and Backscatter Gauges $3,300



CALENDER STACK

Modernize with a new Puseyjones

(YOU FILL IN THE BLANK)



WATERMARKING ATTACHMENT

For 11 months — all during 1953 — we have urged you to modernize your paper-making machinery in order to stay competitive. We have told you about the production advantages of a new Dry Part, a new Press Part, a new Calender Stack, a new Slice, a new Winder, a new Reel, new Steam Joints, and other machine improvements.

Now . . . in December . . . it's up to you. Talk it over with a Puseyjones engineer. Write us today—we will have our District Representative call.

THE PUSEY AND JONES CORPORATION

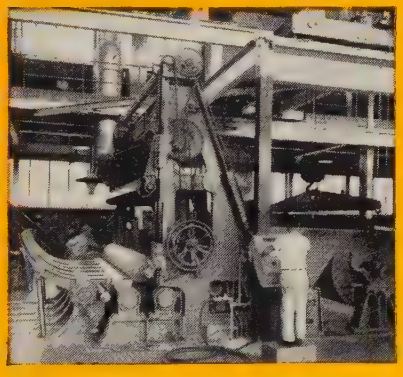
Established 1848. Builders of Paper-Making Machinery

Fabricators and Welders of all classes of Steel and Alloy Products

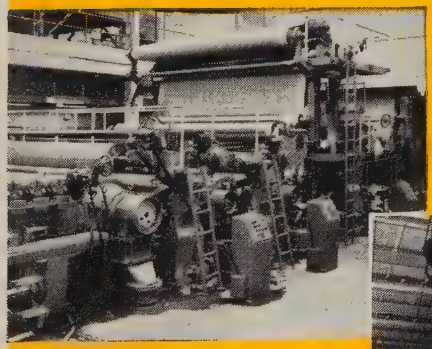
Wilmington 99, Delaware, U.S.A.

THE SIGN OF TRADE MARK SUPERIOR QUALITY

STEAM JOINTS

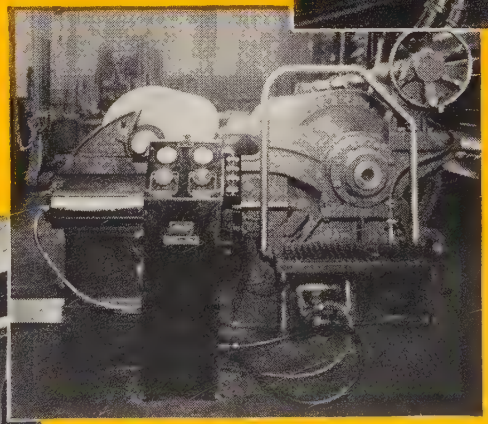


WINDER



PRESS PART

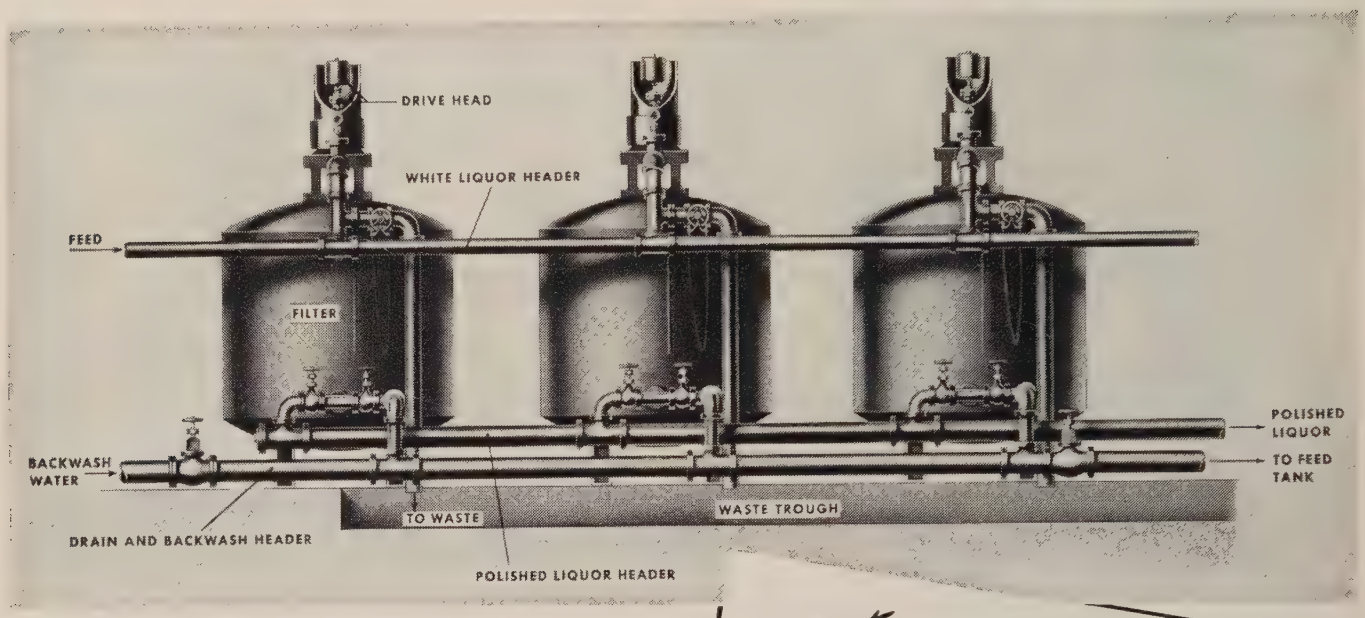
DRY PART



REEL

What's New in Recausticizing Practice?

The DORRCO White Liquor Polishing Station



Designed to fit in as an integral part of new or existing Dorr Continuous Recausticizing Systems, the White Liquor Polishing Station consists of one or more vertical pressure filters and all necessary piping, valves and control instruments. While this development is of particular importance to producers of bleached and dissolving pulps, the assurance of a cooking liquor of uniform purity and clarity is of interest to every producer in terms of better overall operation.

For further information on the Dorrco White Liquor Polishing Station, write The Dorr Company, Stamford, Conn., or in Canada, The Dorr Company, 26 St. Clair Avenue East, Toronto 5.

Facts on the DORRCO White Liquor Polishing Station

Filtering medium of graded anthracite coal entraps colloidal material too fine to be removed economically by gravity.

A uniformly bright pulp is assured regardless of variations in settling and slaking conditions in the recausticizing operation.

A built-in, motor-driven agitator operated during backwashing aids in releasing entrained impurities, breaks up the film of impurities on the surface of the bed and maintains the anthracite bed in good condition.

Exceptionally long filter runs are obtained . . . up to 24 operating hours; with short, 10-20 minute backwashing cycles.

Better tools TODAY to meet tomorrow's demand

DORR

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

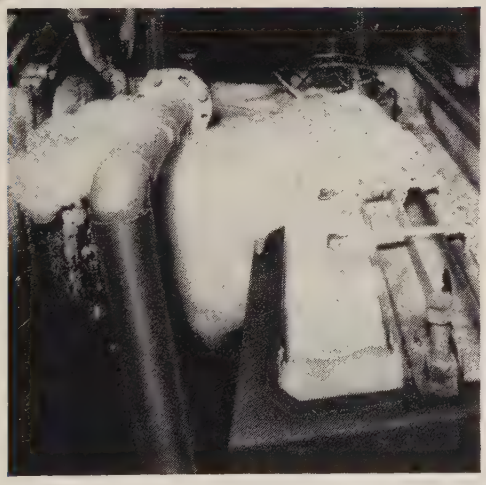
THE DORR COMPANY • ENGINEERS • STAMFORD, CONN.

Offices, Associated Companies or Representatives in principal cities of the world.

FOAM

beautiful here

but not here



Yes, foam is both decorative and useful in milady's bath, but certainly not in the pulp and paper mill where it retards production and lowers quality.

That's why today so many manufacturers are eliminating foam troubles with Nopco* foam killers and sheet formation aids. These superior formulations of liquid and paste defoamers destroy the most obstinate foam in a *matter of minutes*.

Take Nopco KFS, a semifluid paste, for example. Stable to chemicals such as alum and chlorine, and hard water, KFS is a lightning-fast "bubble buster". It provides extremely effective foam control at every stage in pulp and paper making from blow pit to calender color box. KFS, in fact, does a thorough job of foam elimination no matter how great the volume or speed of mill production.

Why not order enough KFS for a trial run? It is easily made into a stable emulsion by simple agitation. And Nopco specialists will gladly work closely with you, right in your mill if you wish, to make certain that you get the best possible results.

Write for free bulletin: "Nopco KF Series Dispersing Agents"—giving valuable tips on how to improve sheet formation.*

*Reg. U.S. Pat. Off.

NOPCO

EVOLVED THRU RESEARCH

NOPCO

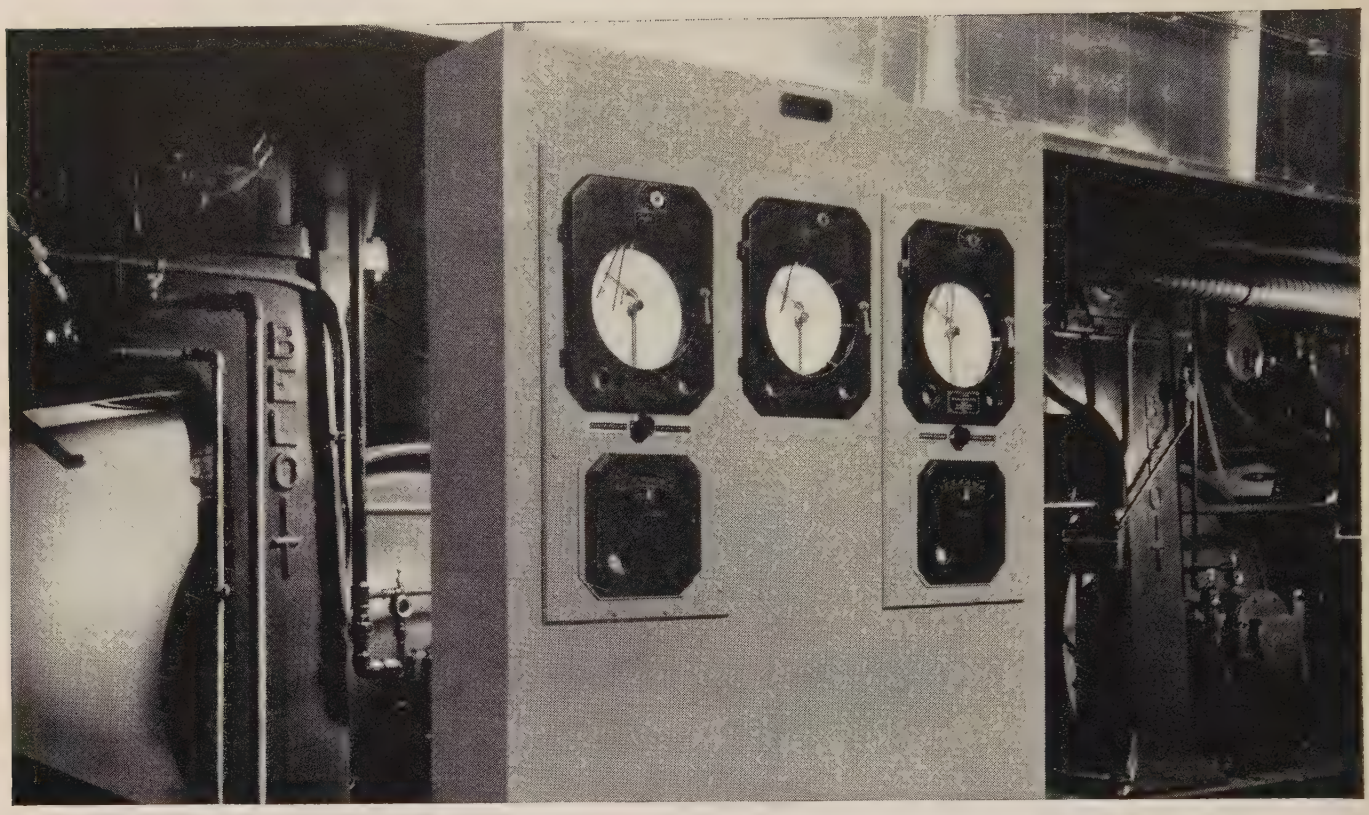
CHEMICAL COMPANY Harrison, N. J.

Branches: Boston • Chicago • Cedartown, Ga. • Richmond, Calif.

LOOK TO NOPCO AS YOUR SOURCE OF SUPPLY FOR:

Foam Killers • Sulfated Oils • Emulsified Resins • Coating Compounds • Wax Emulsions & Emulsifiers • Rewetting Agents Insoluble Metallic Soap Dispersions • Sheet Formation Aids Plasticizers • High Free Rosin Sizes • Pitch Dispersants

Over 300 of these Stamm Moisture Control Systems are giving "Guaranteed Satisfaction"



And Stamm Drying Controls Inc., of Lockport, N. Y., rely on "proven automatic controllers by Taylor" (as they put it) for the successful operation of their system. This simple and practical method of controlling the moisture content of paper is now being used with great success on Board, Kraft, News, Toweling, Tissue, Magazine Book, Bond, Carbonizing, Greaseproof, Glassine and Parchment at speeds from 100 feet to 1700 feet per minute. The unit can be quickly adjusted to handle a wide variety of grades on machines making specialties, and satisfactory operation is obtained on heavy boards running as low as 3% moisture, as well as on very light weight tissues.

With the Stamm Control System: moisture content can be run higher, resulting in greater profit and improved quality of the sheet. Breaks and snapoffs in the dryers are greatly reduced. A more uniform finish is assured. The backtender doesn't have to give constant attention to drying. And constant moisture means constant physical properties. Picture above shows the main control panel for 2 Stamm control systems in use at a well known Southeastern Paper Mill, making a quality kraft sheet. The Taylor Fulscope* Recording Ratio Controllers (*at top*) control the main steam supply to the dryers, and provide a continuous record of steam pressure, moisture variations, breaks and down time. The Indicating Controllers (*below*) are Constant Pressure Regulators, used as manual controls during periods when the sheet is off the machine. The fifth instrument (*center*) controls the wet end section.

This is another example of how Taylor is working successfully with the manufacturers of equipment for the paper industry. Why not call your Taylor Field Engineer —or write Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

*Reg. U. S. Pat. Off.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

—MR. PAPER MILL OPERATOR—

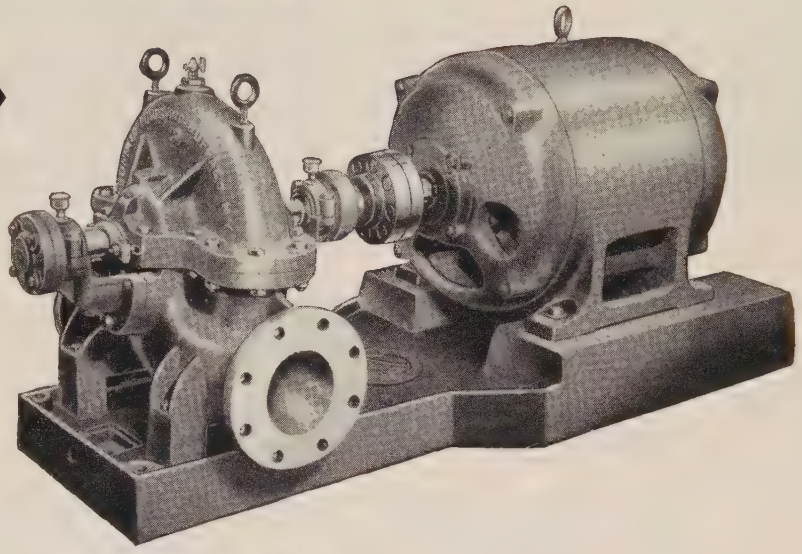
"Buffalo" HIGH EFFICIENCY PUMPS Increase Profits for you BY REDUCING COSTS

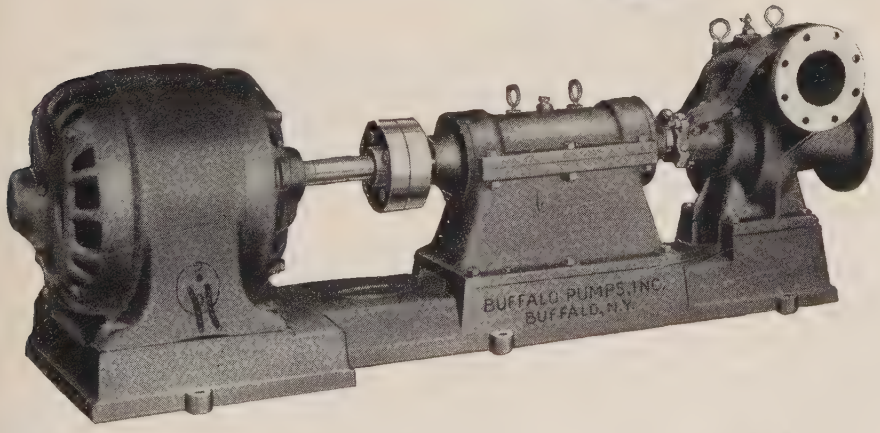
We think you'll agree—the answer to greater profits is lower operating cost. In pumps, that means greater efficiency, long-life, and easy maintenance. These factors are engineered into every "Buffalo" Pump. It is no surprise that they're continually proving long-run economy in the industry—because they were designed by "Buffalo" engineers working closely with paper men.

DOUBLE SUCTION WHITE WATER PUMPING

The versatile Type "SL" is one of the paper industry's most willing workers. Built for capacities from 10 to 14,000 GPM, it has "Buffalo" simplified design, maximum durability, and easy access to enclosed impeller. Inspection can be done without disturbing piping. Maintains hydraulic balance constantly.

Write today for Full Information on "Buffalo" Pumps specifically designed for efficiency in the paper industry.





NON-CLOGGING STOCK PUMPS

Ruggedly-built non-clogging enclosed impeller keeps stock flowing without costly breakdowns, giving you greater output per hour. Maintenance is simplified so that, by removing only a few bolts, impeller and bearings can be inspected, without disturbing discharge piping. Handles up to 6% consistencies satisfactorily.

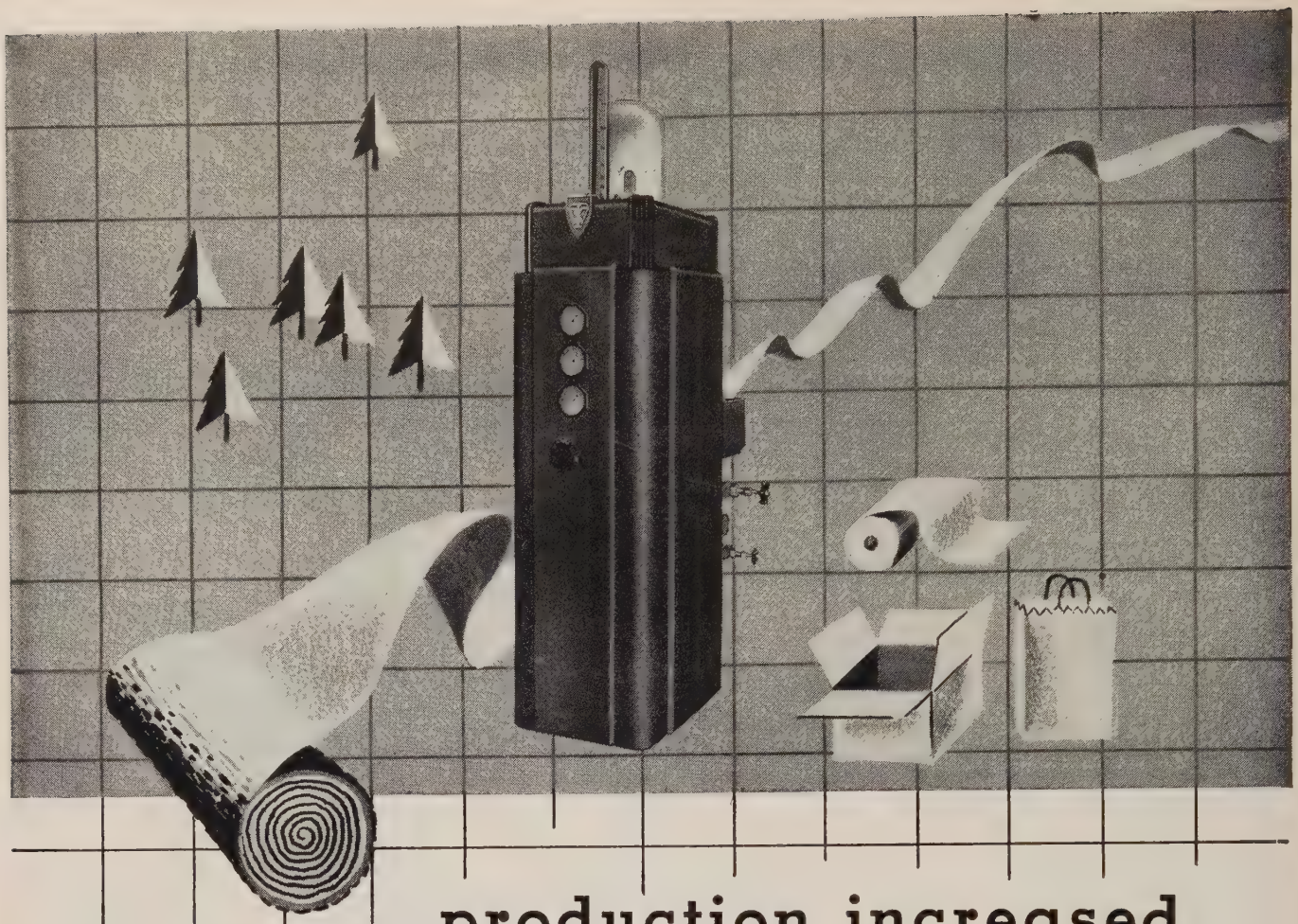
"Buffalo" BUFFALO PUMPS, INC.

528 BROADWAY BUFFALO, N. Y

Subsidiary of Buffalo Forge Company

Canada Pumps, Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



production increased up to 15 tons per day...

. . . with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in. Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

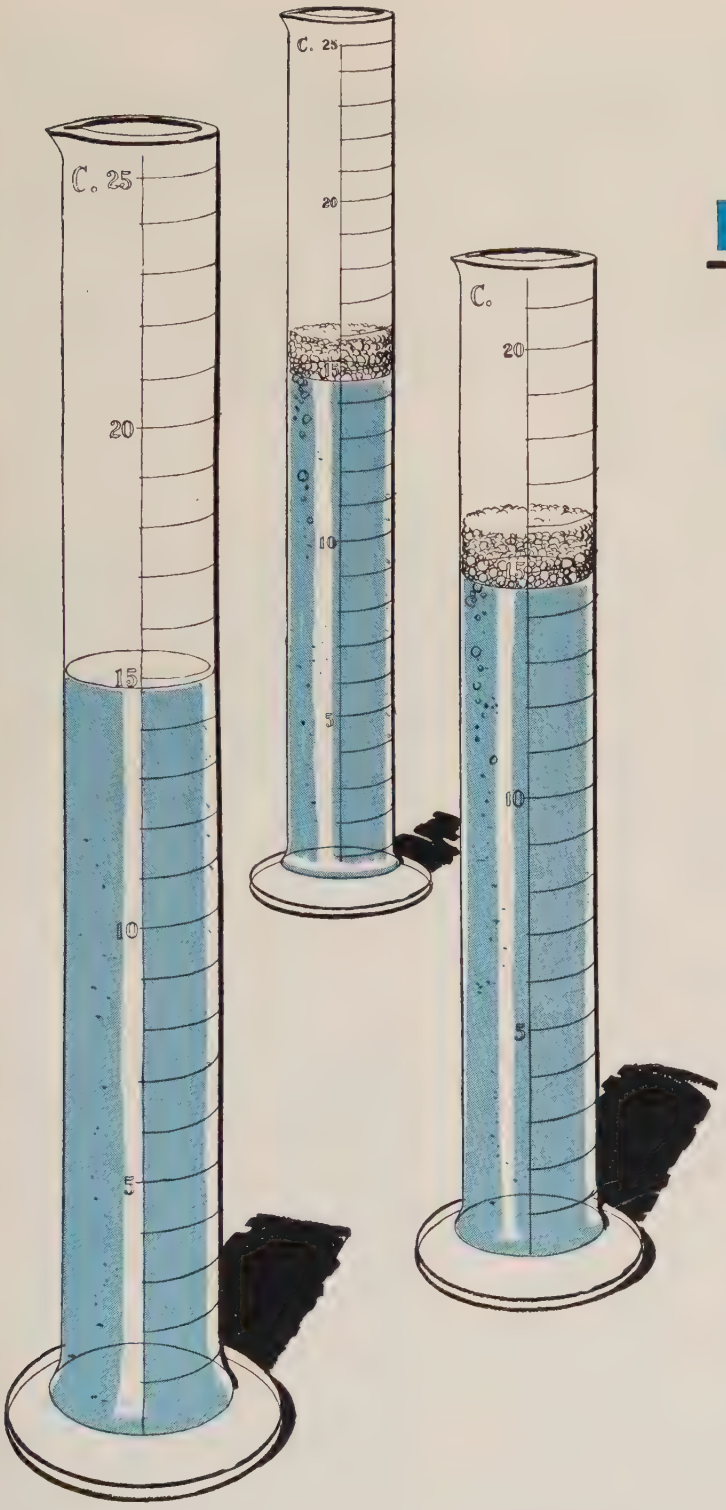
During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime! Performance such as that is typical of what your W&T representative can do for you.

If you have a production problem attributable to impure water, it would pay you to write or call him now.

WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

I-42



you get **low foaming** in **three sizes** from *Cyanamid*

Some mills prefer the high-sizing efficiency of a fortified size . . . some find a standard size works out best under their particular operating conditions . . . some find a dark size perfectly suitable.

But most mills find operating economy in the low foaming characteristic of Cyanamid rosin sizes.

Many mills have long benefited by this Cyanamid development – offered first in our ACCOBRITE® Rosin Size, and most recently in CYFOR® Fortified Rosin Size and FF Dark Rosin Size.

Take advantage of the selection offered you. Call our technical representative now to help you select the *right* size to suit your needs . . . and get the added advantage of *low foaming*.

CYFOR Fortified Rosin Size – in many mills low foaming CYFOR has produced higher sizing results at lower cost . . . reducing size consumption as much as 50% over standard sizes.

ACCOBRITE Rosin Size – preferred under some production conditions for sizing efficiency; gives high whiteness, little drop-off in brightness on aging with no foaming problems.

FF Nonfoaming Dark Rosin Size – ideal for kraft and paperboard furnishes where whiteness is not as important as economy and freedom from foaming.

AMERICAN *Cyanamid* COMPANY
PAPER CHEMICALS DEPARTMENT T-12.
30 Rockefeller Plaza, New York 20, N. Y.
In Canada: North American Cyanamid Limited, Montreal and Toronto

Sales Offices: Boston · Charlotte · Chicago · Cleveland · Kalamazoo · Seattle · Los Angeles · Mobile · New York · Philadelphia

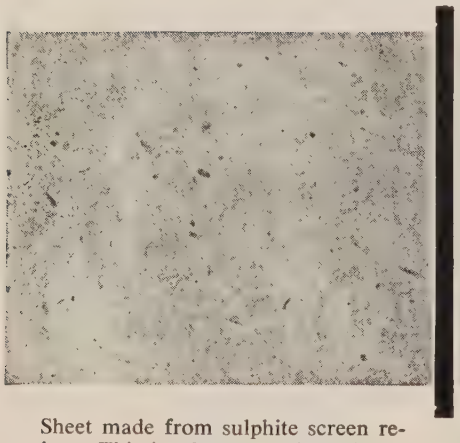
Results are spectacular with

Bauer CENTRI • CLEANERS

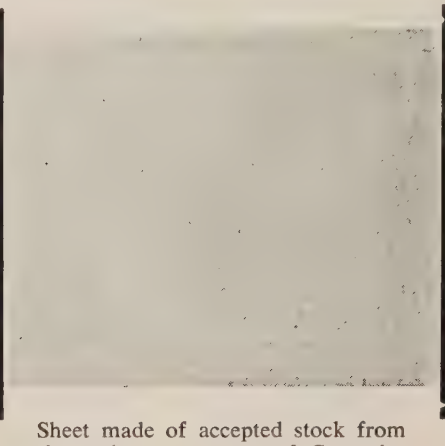
Everyone who sees examples of the work done by Centri • Cleaners is astonished at the results. The examples are sheets made from the stock which goes into the Centri • Cleaners, sheets made from the accepted stock, and sheets made from the final rejects. Some photographic reproductions are shown below, but they are not as sensational as the sheets themselves.

Our representatives have assortments of sheets from a number of kinds of stock processed with the No. 600 and No. 622 Centri • Cleaners. If you wish to see the examples, let us know and our representative in your area will show them to you on his next call.

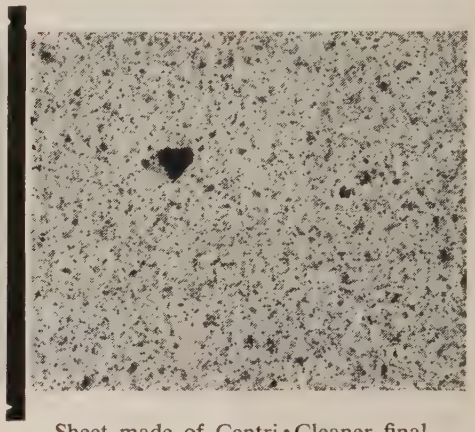
In the meantime, we suggest that you ask for our Bulletin No. P-4 which explains the construction and operation of Centri • Cleaners.



Sheet made from sulphite screen rejects. This is what went through the Centri • Cleaners.



Sheet made of accepted stock from the primary group of Centri • Cleaners.

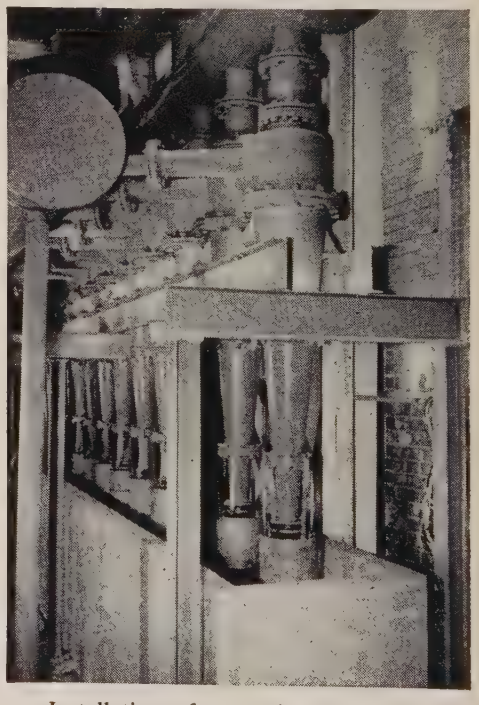


Sheet made of Centri • Cleaner final rejects. This sheet consists of sand, bark, shives, and other refuse.

Overhead view of No. 600-3″ Centri • Cleaners manifolded into inlet and outlet headers. These Centri • Cleaners are cleaning unbleached sulphite pulp.

Our representative will be glad to show you actual examples of work done by Centri • Cleaners.

Ask for Bulletin No. P-4



Installation of ten primary and one secondary No. 622-12″x4″ Centri • Cleaner ahead of a paper machine. Each group is manifolded into inlet and outlet headers.

THE BAUER BROS. CO. • 1715 Sheridan Ave. • Springfield, Ohio

Quality Paper Making calls for OK BRAND STARCHES

for tub, beater and calender sizing—
for coating and adhesives

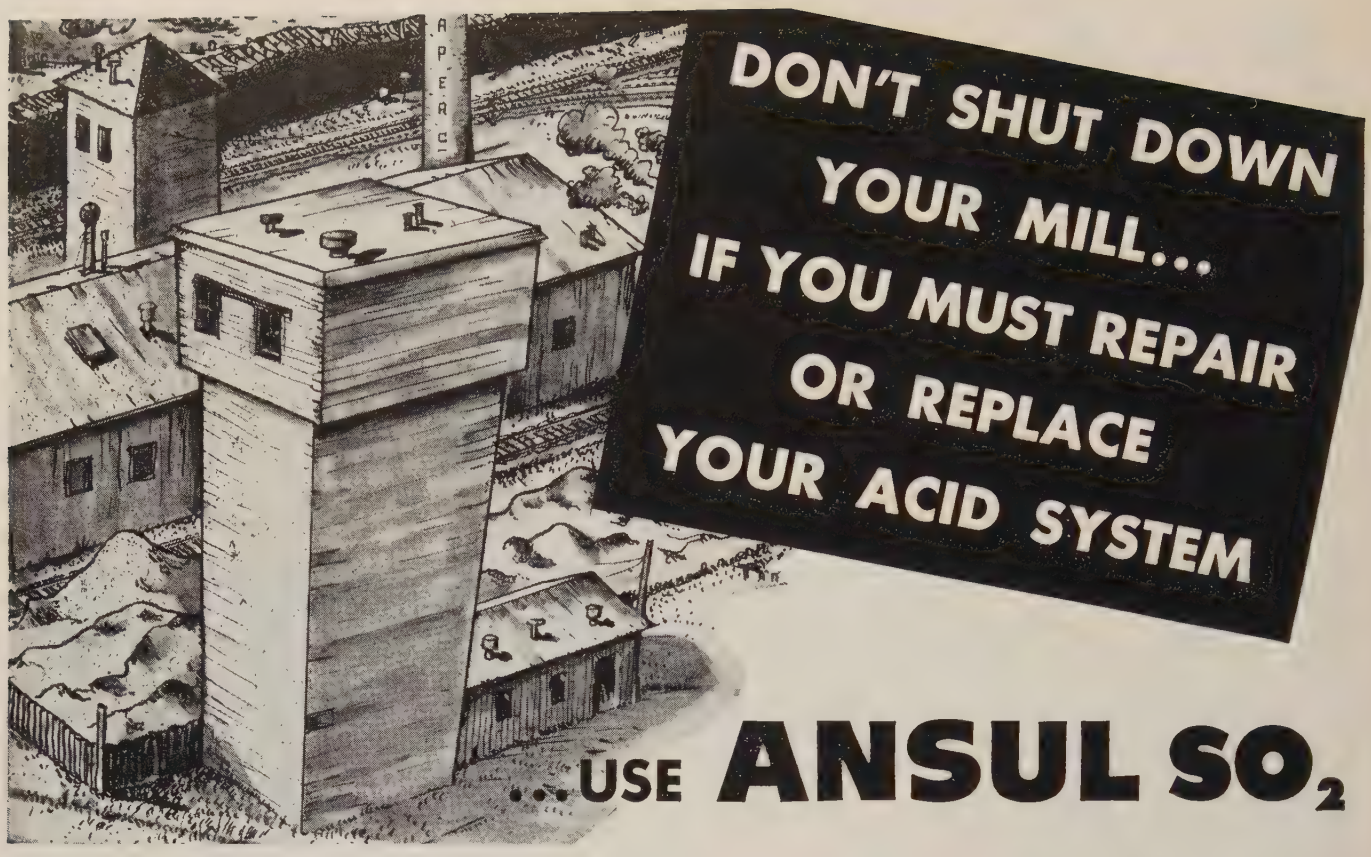
FREE TECHNICAL SERVICE!

Some of the industry's outstanding experts in the use of starch in paper making are on the staff of Hubinger's famous laboratories. You are invited to consult these experts on your production problems—without cost or obligation on your part.

...the Stamp of Quality!

THE HUBINGER CO. (EST. 1881), KEOKUK, IOWA

Branch offices: New York • Boston • Charlotte • Chicago • Los Angeles



and maintain maximum production

If you must repair or replace your sulfur burner, combustion chamber or gas coolers, use Ansul liquid SO_2 and keep your mill operating at capacity.

1. Avoid interruption of acid plant operation.
2. Maintain peak capacity in pulp plant during repairs of acid systems.
3. Get proper balance between free and combined SO_2.
4. At a very small installation cost.

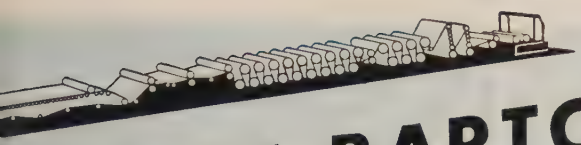
Ansul liquid SO_2 may be added simultaneously at one or more points in the system. Prepare for an emergency. Consult the Ansul Technical Staff NOW. Learn how easy and economical it is to avoid shutdown headaches.

Write for file No. 400. You will receive information on how to use Ansul SO_2 to 1) fortify your cooking acid, 2) improve your digester schedules, 3) obtain more complete pulping, 4) get better screening of pulp and, also, 5) for green wood cooks.

ANSUL
Chemical Company
INDUSTRIAL CHEMICALS DIVISION • MARINETTE, WISCONSIN

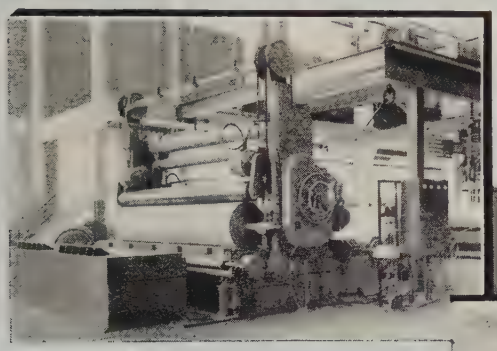
MANUFACTURERS OF INDUSTRIAL AND FINE CHEMICALS, LIQUEFIED GASES, REFRIGERATION PRODUCTS AND FIRE EXTINGUISHING EQUIPMENT.

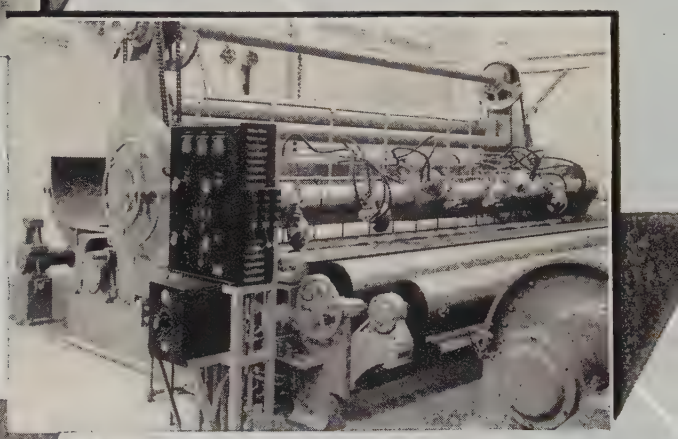
Over a MILE a MINUTE

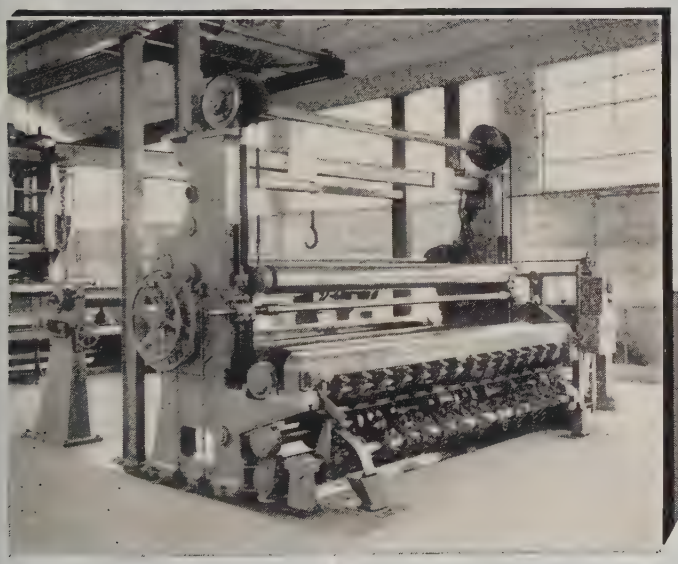


RICE BARTON WINDERS

Handle ALL GRADES · ALL WIDTHS · ALL SPEEDS!







True dynamic balance, Automatic braking, Collective deceleration, Hydraulic weight compensation, Automatic sheet passing and roll ejection, Single control air operated slitters . . .

You get all these and SPEED too, when you buy a Rice Barton Winder.

RB12-53

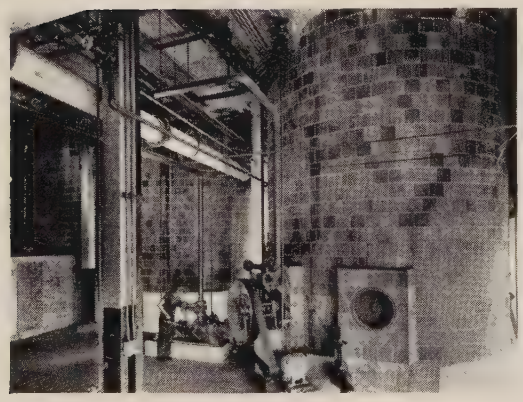
RICE BARTON CORPORATION

Worcester, Massachusetts

Paper Machine Builders Since 1837

West Coast Distributor: **Ray Smythe** · 501 Park Building · Portland, Oregon

We Design and Build BIG Tile Structures



Complete service — design, engineering, construction, maintenance — of corrosion-resistant storage and process structures — from the smallest to the largest.

For wet materials, these structures are reinforced concrete faced on both sides with glazed tile; for dry materials, they can be either this same construction or steel-reinforced hollow tile.

70 Years of Successful Corrosion Resistant Installations throughout the North American Continent

Write for Bulletin A-153

SINCE 1884
Specialists in Design Installation and Servicing of Linings and Tile Tanks

SEMCO

STEBBINS

Engineering and Manufacturing Company, Watertown, N. Y.

STEBBINS ENGINEERING CORP. — TEXTILE TOWER, SEATTLE, WASH.

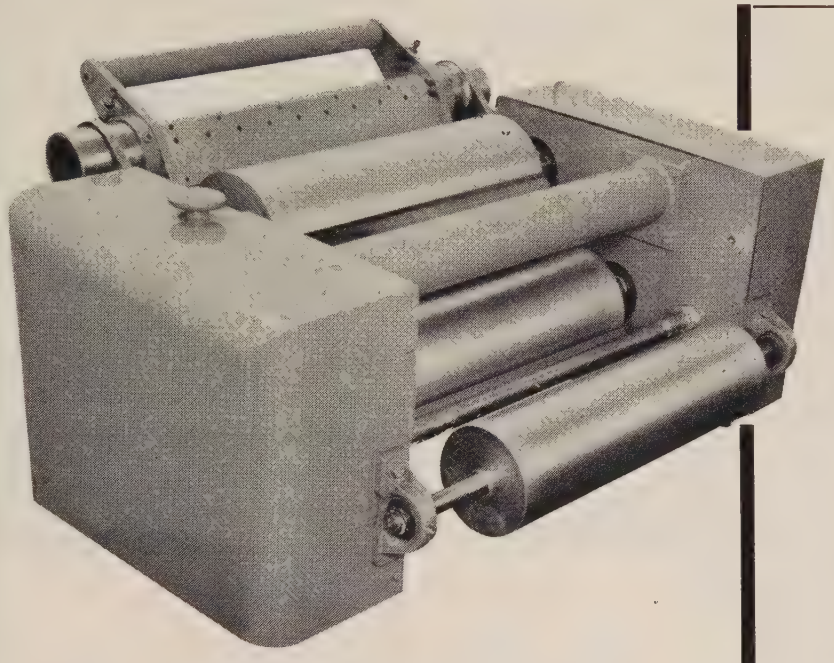
CANADIAN STEBBINS ENGR. & MFG. CO., LTD. — CASTLE BLDG., MONTREAL, CANADA

FOR COATING ACCURACY AND SPEED

No Other Machine Equals The Newest

MICROJET

TRADE MARK REG.



Applies clay coatings to paper at speeds up to 1000 F.P.M. Produces good coverage on rough surfaces with up to 50% less coating. Ideally suited for applying abrasive coatings since metering is accomplished by air alone and without mechanical devices.

NOTE THESE FEATURES

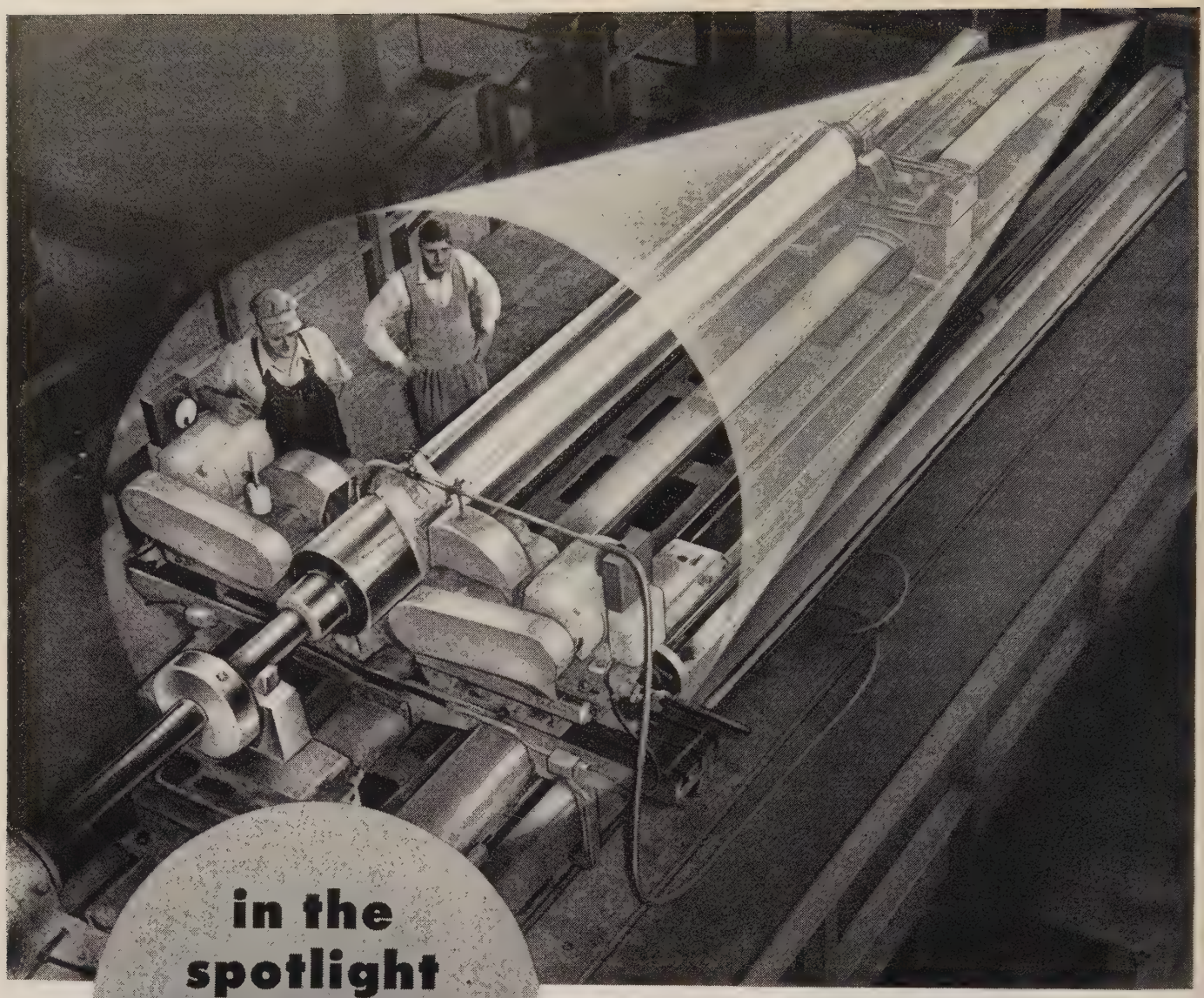
- **High Speed Operation**
- **Simple Control of Coating Weight**
- **Versatility and Flexibility**
- **Uniformity of Finished Surface**
- **"Uniflow" Nozzle for Highest Efficiency and Continuous Operation**
- **Completely Enclosed Drive and Mechanisms**
- **Ball Bearings Throughout**
- **Controls Located for Ease of Operation**
- **Automatically Guided Suction Apron Available**

Our new Testing and Research Laboratory is complete in pilot plant equipment to determine exact requirements prior to final machine specifications. Submitting samples will assist us in our laboratory analysis of your particular problem.

John WALDRON Corporation

P. O. BOX 791 · NEW BRUNSWICK · NEW JERSEY

Leaders In Web Process Engineering Since 1827



in the spotlight

Again . . . **LOBDELL**

G.H.V. 42" ROLL GRINDER

The vast and recently completed expansion program of Weyerhauser Timber Company, Longview, Washington, includes a LOBDELL Type GHV Roll Grinder along with many other fine items of equipment . . . for greatly increased production. And LOBDELL Roll Grinders, a design available for *every* need, are exactly "The Grinders" to facilitate today's stepped-up production standards.

Due to earth conditions, the Type GHV in this case was mounted on a Korfund spring isolated foundation.

LOBDELL Roll Grinders—two types: GHV with alternating current, constant speed motors; CW with direct current, variable speed motors. Completely automatic. Low Head Wheel Carriage, patented Infeed Mechanisms and Automatic Crowning Device assure greater accuracy and higher degree of finish on your rolls. Rugged, dependable, simple . . . and accurate to .00025" for parallelism and concentricity. LOBDELL grinders can do *your* job.

Write, today, for Roll Grinder Catalog.

LOBDELL also produces Machine Calender Stacks, Chilled Iron and Alloy Chilled Rolls and Micrometer Roll Calipers.

1836 **LOBDELL UNITED COMPANY** 1953

WILMINGTON 99, DELAWARE

A SUBSIDIARY OF UNITED ENGINEERING AND FOUNDRY COMPANY

FOR POWER
Bituminous of every type for efficient burning in the latest pulverized-fuel installations
FOR COKING
Bituminous coals of exceptional quality for by-product coking
FOR STEAM
Firm-structured Bituminous with high heat values for every steam-plant use
FOR SPACE HEATING
Many varieties of non clinkering coals ideal for stoker use and hand firing
Always ready to serve you...

with a coal that's exactly right

Name your choice—in "Bituminousland" along the Baltimore & Ohio, we have it! Here Nature has stored a supply of economical heat and energy sufficient to last for centuries.

B&O Bituminous coals exist in wide variety. The mines that produce them are thoroughly mechanized so that costs are kept low, size and quality uniform. Nearness to industrial centers results in low transportation costs, and the ease of storing removes the need for expensive facilities. Furthermore, new methods and equipment have increased the burning value of Bituminous.

ASK OUR MAN! Let him direct you to the best coal for your needs, and explain proper firing methods. You'll be more than pleased at the improved efficiency, economy, and cleanliness of B&O Bituminous.

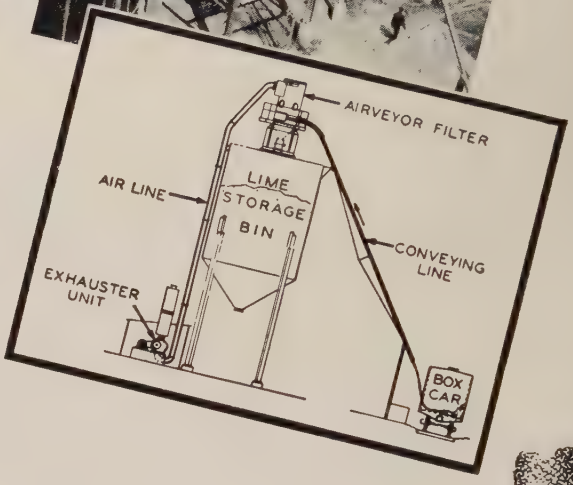
BITUMINOUS COALS
FOR EVERY PURPOSE

BALTIMORE & OHIO RAILROAD

Constantly *doing things*—better!

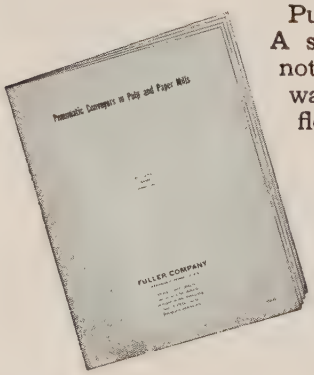
The AIRVEYOR®

ON YOUR FLOW SHEET
ADDS DOLLARS
TO YOUR BALANCE SHEET



Flowing lime, soda ash, salt cake, starch, and clays from one location to another has been proved the simplest, most economical conveying system for the paper industry. Time and again, leading manufacturers have reported increased operating efficiency.

Conveying by air is a specialty of the Fuller Company . . . twenty six years' experience in this field, places it in the top position to recommend and design the system which will give you the best and most economical results. If you're interested in keeping costs for conveying your dry mill-supply chemicals at the minimum . . . if you want to keep waste and losses at the minimum . . . if you want to improve your operating balance sheet . . . you want to talk to Fuller.



Put your conveying problems squarely up to Fuller. A study of your conveying operations will cost you nothing . . . may well be your first step forward toward consistently profitable operation and a smoother flow of production.

Write for reprint of article, "Pneumatic Conveyors in Pulp and Paper Mills", presented at the Sixth Engineering Conference of TAPPI, Oct. 17, 1951.

FULLER COMPANY—CATASAUQUA, PA.

Branch offices

Chicago—San Francisco—Los Angeles—Seattle—Birmingham

A-170
2057

Fuller• ENGINEERS IN PNEUMATIC CONVEYING

Advantages —

- **EASIER TO BURR**
- **HOLDS PATTERN LONGER**
- **MORE UNIFORM GRINDING ACTION**

YOU'LL like the New G Bond that is now available for use with Norton Pulpstones of ALUNDUM and 38 ALUNDUM* abrasives. It will enable you to get the highest quality, cleanest pulp for longest periods. It is another Norton improvement to help you meet today's competitive conditions. Ask your Norton Pulpstone Engineer about the new G Bond stone.

NORTON COMPANY, WORCESTER 6, MASS.

Norton Company of Canada, Ltd.
Hamilton, Ontario

*Shown in illustration above

NORTON
PULPSTONES

Making better products...to make other products better

Abrasives · Grinding Wheels · Grinding and Lapping Machines · Refractories · Porous Mediums · Non-slip Floors · Norbide Products

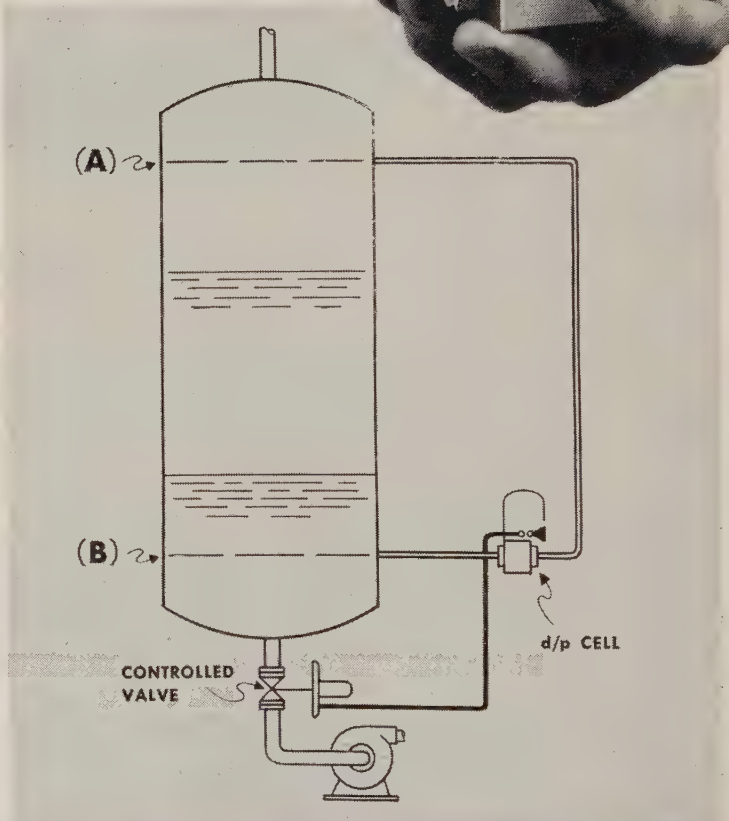
Floatless Liquid Level Control... for

- condensate level in digester heaters and black liquor evaporators
- brown stock washer filtrate tank level
- precipitator wet bottom level
- other pressurized-vessel processes

RIGHT FROM THE START the simple design and operation of the Foxboro d/p Cell will save you time and money on many liquid level control applications. This unique differential pressure transmitter eliminates maintenance problems of float-type controllers. And it operates the valve pneumatically, without additional control devices.

The Foxboro d/p Cell is light in weight, compact, Type 316 Stainless Steel construction. Ranges from 25" to 800". Initially low in cost, the d/p Cell installs externally with simple piping connections.

For the logical solution to *your* liquid level control problems, investigate the Foxboro d/p Cell. Write for Engineering Data Sheet 000-12.



The d/p Cell measures differences in heads between maximum level (A) and minimum level (B) — transmits air pressure *directly* to control valve, in proportion to level change. Prevents pump cavitation and tank overflow.

THE FOXBORO COMPANY, 7812 NEPONSET AVENUE, FOXBORO, MASSACHUSETTS, U. S. A.

FOXBORO REG. U. S. PAT. OFF. d/p cell

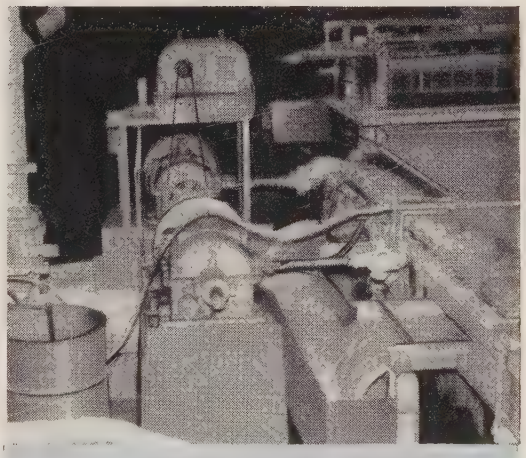
FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

. . . using *Nalco* SPECIALIZED CHEMICAL SERVICES

Newton Falls Paper Mill, Incorporated, Newton Falls, New York, has earned the title of A Mill of Tomorrow through use of highly advanced equipment and very precise quality control at all stages of the papermaking process.

Nalco Specialized Chemical Services used at Newton Falls tie in closely with this quality control program. They include Nalco slime control and antifoam chemicals, fed accurately and automatically to the system; and Nalco 680 for better fibre and clay retention and improved pH control.

For prompt, expert assistance in applying these, and other Nalco System products and services to your mill operation, contact your Nalco Representative or write direct.



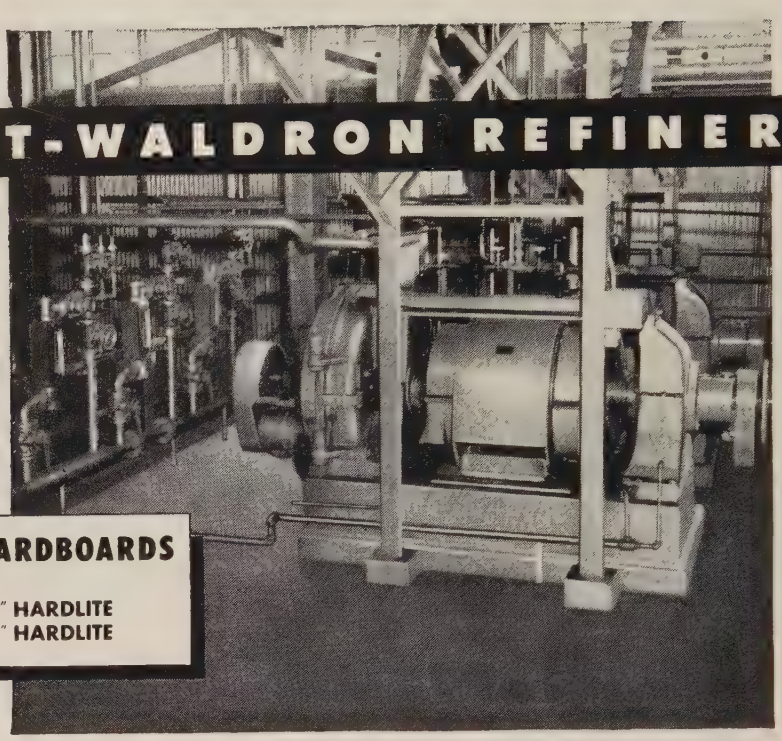
Foam bubbles eliminated on wire and in tray discharge by Nalco antifoam treatment at Newton Falls.

NATIONAL ALUMINATE CORPORATION
6197 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco*® SYSTEM...Serving the Paper Industry through Practical Applied Science

Another HARDBOARD PRODUCER Chooses

SPROUT-WALDRON REFINERS



The Oregon Lumber Company
Dee, Oregon
manufacturers of

Simpson allwood HARDBOARDS

1/8" STANDARD	3/16" HARDLITE
3/16" STANDARD	1/4" HARDLITE
1/4" STANDARD	

Solves Pulping Problems

the S/W way

Two Sprout-Waldron 36-2 Refiners pulp Asplund fiber from waste wood and bark—for the well-known Simpson Allwood hardboard.

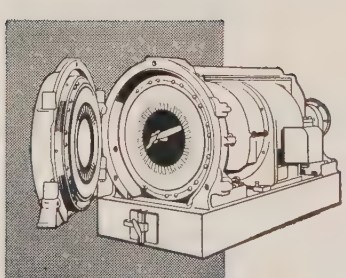
to obtain

- **High pulp quality**
- **High capacity**
- **Flexibility of operation**
- **Rugged construction**
- **Low maintenance**

want to know **WHAT'S NEW** ***in pulping processes?***

BETTER FIBERS, a Sprout-Waldron technical publication, brings you important information on new and improved pulping processes — especially in semi-chemical pulping. We will gladly send your copy regularly. Write to Sprout-Waldron & Co., Inc., 38 Logan Street, Muncy, Pennsylvania.

S W



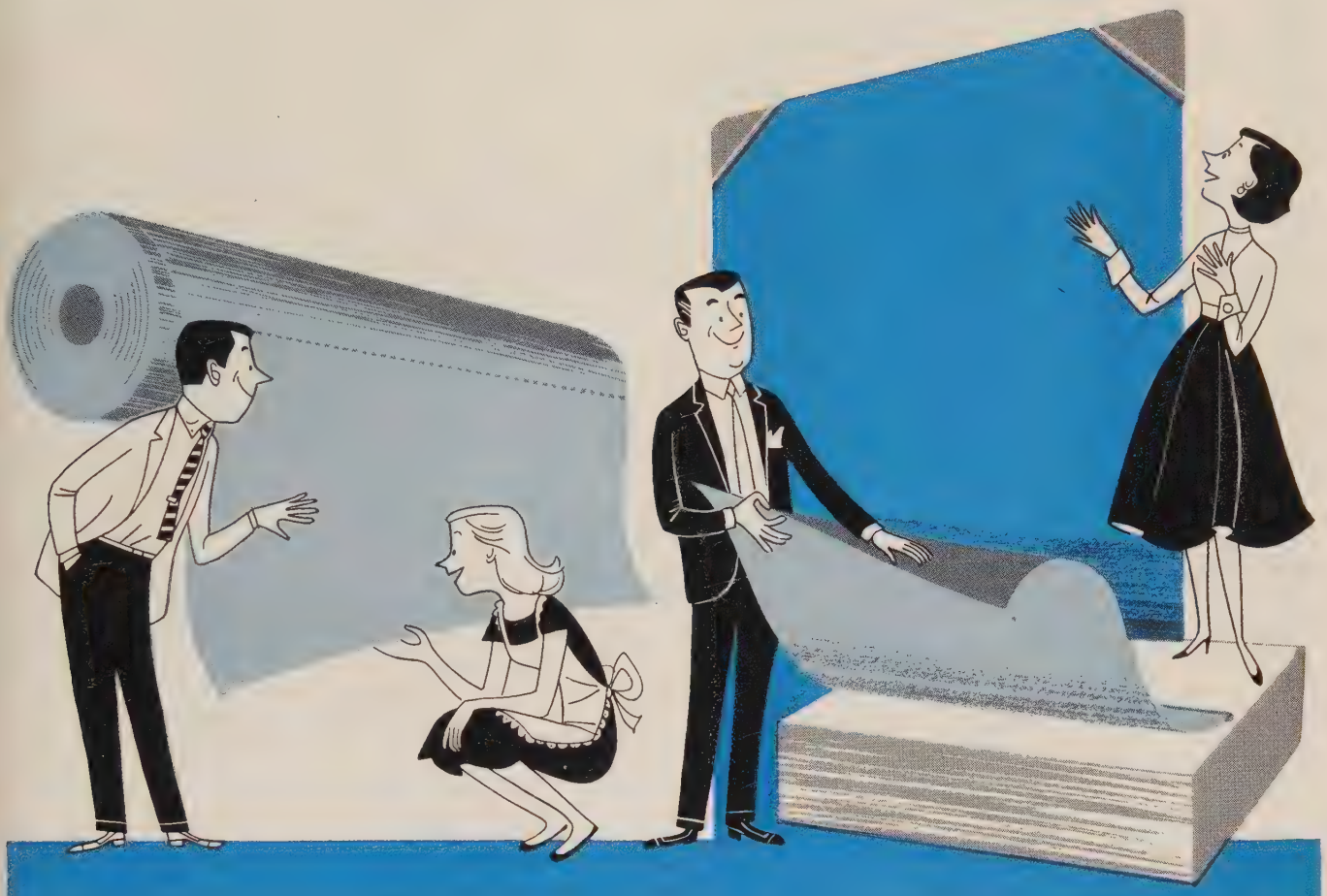
SPROUT-WALDRON

PULP REFINERS

258

for pastel blue

...tinting, too!



PHENO SKY BLUE 6BX CONC.

This Calco direct dye gives excellent results in tinting white shades and in producing pastel blues. It offers good bleed resistance and chemical stability, and is generally preferred for papers destined to come in contact with alkali.

In conjunction with Chrysophenine ESN Ex. Conc., Pheno Yellow 3GX Conc. or Pheno Fast Yellow 3AP Conc., PHENO SKY BLUE 6BX CONC. produces the bright greens which, in addition to the clean blues, are preferred for napkins, toweling, tissue and waterleaf grades.

Calco®

AMERICAN Cyanamid COMPANY

CALCO CHEMICAL DIVISION
DYESTUFF DEPARTMENT
BOUND BROOK, NEW JERSEY

NEW YORK • CHICAGO • BOSTON • PHILADELPHIA • CHARLOTTE • PROVIDENCE

NORTH AMERICAN CYANAMID LIMITED, CALCO CHEMICAL DIVISION
MONTREAL—TORONTO

The many sections of SOLVAY'S Industry-Wise TECHNICAL SERVICE *are always ready to help you!*

SOLVAY has a Technical Service Staff of engineers, chemists and technicians *specifically trained for individual industries!* They are available at all times—to assist you with your problems—AT NO COST OR OBLIGATION!

THESE TOP-NOTCH CONSULTANTS are ready to cooperate with you—in the development of a new or improved process for your particular situation . . . suggest better methods of handling, storing and using industrial alkalies . . . and furnish complete details on all SOLVAY products.

THESE SERVICES INCLUDE: SOLVAY'S *field service* . . . SOLVAY'S *laboratory service* (with the best alkali research facilities in the world) . . . and SOLVAY'S extensive series of *technical bulletins.*

EACH SEPARATE SECTION is prepared to work with you on your individual problems—*in complete confidence.* Among these sections are: glass, paper, textiles, ceramics, water and industrial waste, dairies and launderies, concrete, highway construction and maintenance.

. . . So today—why not 'phone or write your nearest SOLVAY office for further information?

SOLVAY PROCESS DIVISION
ALLIED CHEMICAL & DYE CORPORATION
61 Broadway, New York 6, N. Y.

BRANCH SALES OFFICES:
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Detroit • Houston • New Orleans • New York • Philadelphia
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Soda Ash • Sodium Bicarbonate
Caustic Soda • Caustic Potash
Potassium Carbonate • Chlorine
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Ammonium Bicarbonate • Cleaning
Compounds • Snowflake® Crystals
Calcium Chloride • Para-dichlorobenzene
Ortho-dichlorobenzene • Monochlorobenzene

THE KEYS TO ADVANCED METHODS OF Stock Preparation

THICKNERS

PROPELLER AGITATORS

STOCK & WATER PUMPS

STOCK CHESTS

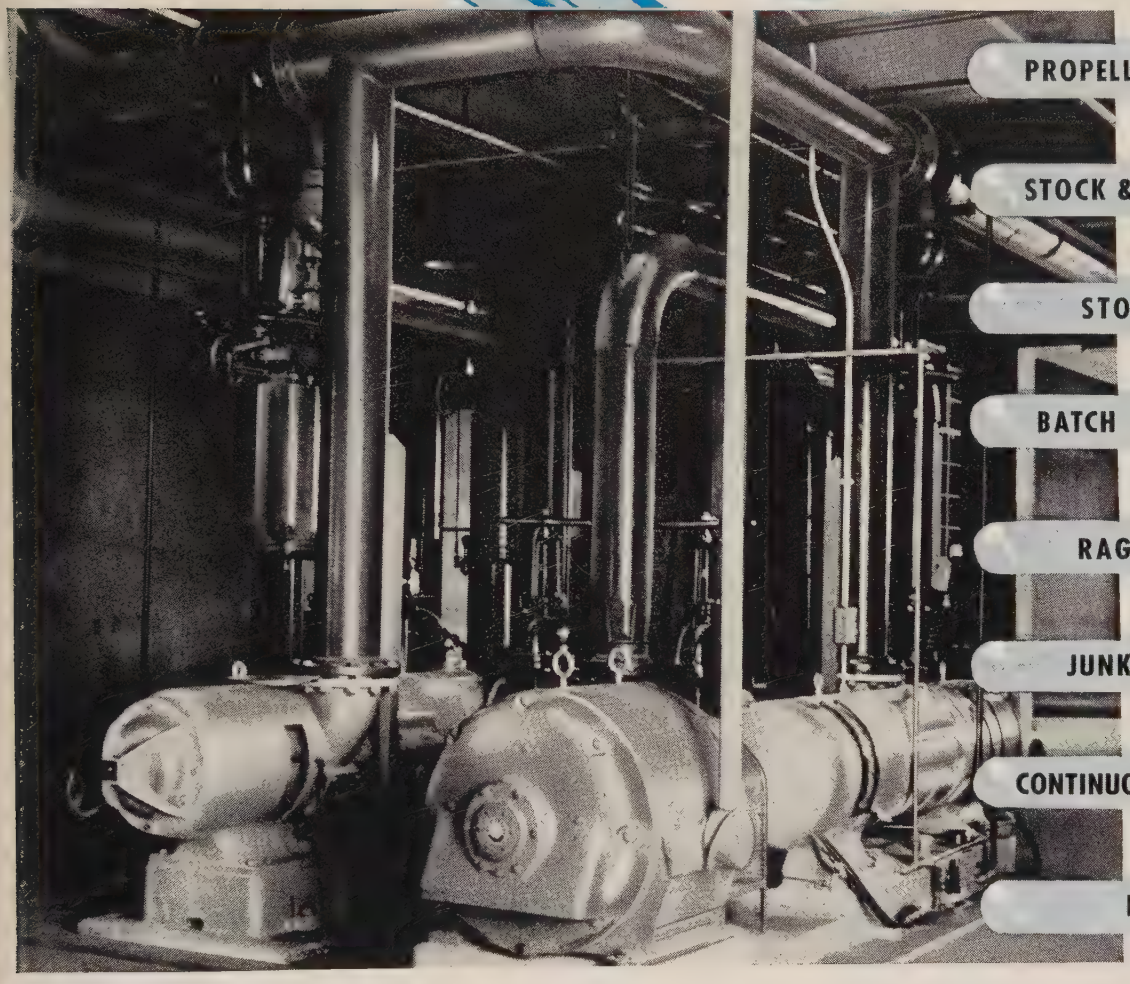
BATCH FIBREPULPERS

RAG CATCHERS

JUNK REMOVERS

CONTINUOUS FIBREPULPERS

BEATERS



Two Downingtown FIBREFINERS used in the preparation of stock in a mill producing gypsum liner grades and box boards.

The Dictionary Says . . . *"to integrate" means "to bring parts together to make a whole."*

Downingtown will integrate any of the above stock preparation equipment into your present mill or your plans for a new mill for more profitable operation.

In Canada, the Downingtown Fibrepulper is manufactured by Waterous Ltd., Brantford, Ontario.

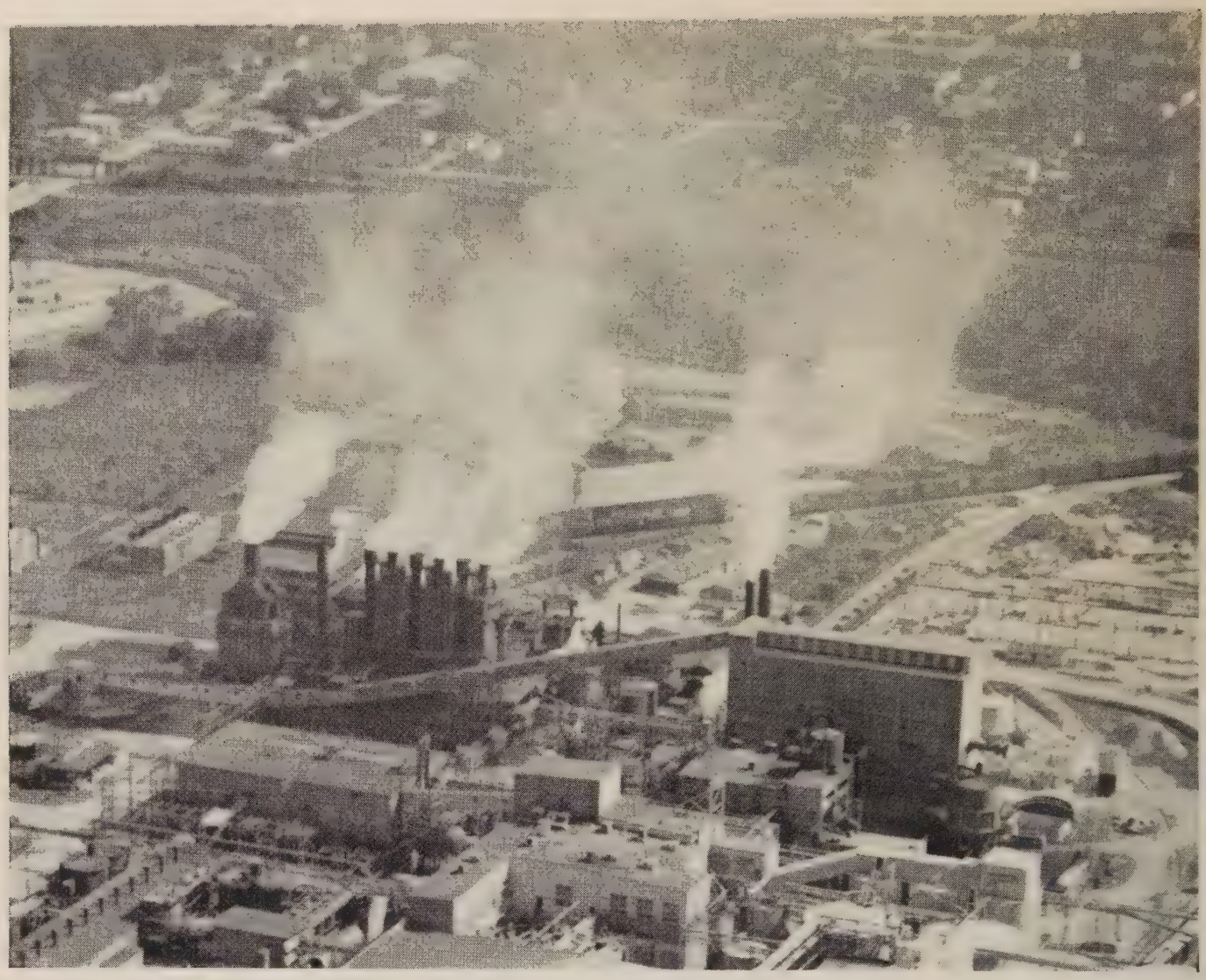
DOWNINGTOWN MANUFACTURING CO. DOWNINGTOWN, PA.

West Coast Representative: John V. Roslund, Pacific Building, Portland 4, Oregon

DOWNINGTOWN

DESIGNERS AND BUILDERS OF PAPER, BOARD AND FELT MACHINES SINCE 1880

MODERNIZATION IS PROFITABLE



There's good will in the air

. . . when your odor abatement program is really effective

Even at the most modern pulp mills, escaping sulfide odors continue to be a major problem. Condensing, scrubbing, or burning the waste gases have not been the complete solution to effective odor abatement—odor abatement that literally means "good will in the air."

Du Pont chemists and engineers, who have worked closely with management, engineers, and production men at most of the country's leading pulp mills, turned their attention to helping them work out their waste gas odor problems. As a result of these experiences, specially engineered odor-masking compounds—Du Pont "ALAMASK" odor-masking compounds—were developed.

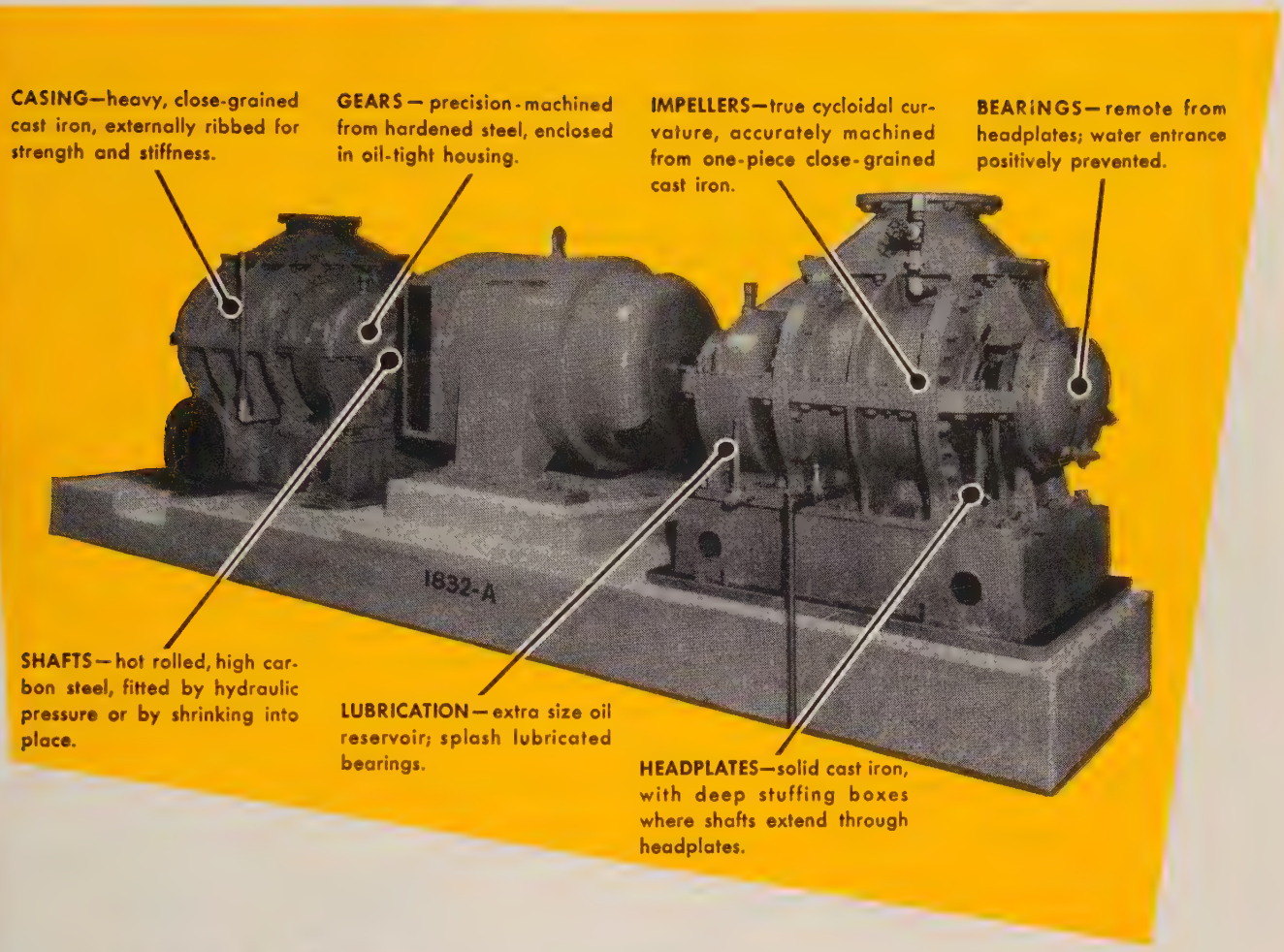
In actual mill operations, the use of "ALAMASK" has effectively reduced the noticeable malodors. As these operations continue, priceless good will is being built for the mills with their communities and with their employees.

Perhaps Du Pont "ALAMASK" odor-masking compounds, combined with Du Pont experience in the pulp and paper industry, can be the answer to your odor abatement problem. For information and technical service, write to E. I. du Pont de Nemours & Co. (Inc.), Organic Chemicals Department, Wilmington, Delaware.

Du Pont **Alamask**
REG. U.S. PAT. OFF.
Odor-Masking Compounds

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY


CASING—heavy, close-grained cast iron, externally ribbed for strength and stiffness.
GEARS—precision-machined from hardened steel, enclosed in oil-tight housing.
IMPELLERS—true cycloidal curvature, accurately machined from one-piece close-grained cast iron.
BEARINGS—remote from headplates; water entrance positively prevented.
1832-A
SHAFTS—hot rolled, high carbon steel, fitted by hydraulic pressure or by shrinking into place.
LUBRICATION—extra size oil reservoir; splash lubricated bearings.
HEADPLATES—solid cast iron, with deep stuffing boxes where shafts extend through headplates.

REDUCE your operating costs with . . .

Successful experience of users proves the operating economies of the improved design of Roots-Connersville Vacuum Pumps for paper mills. Whether needs call for single-stage or compound units, these important advantages result:

1. **Lower operating cost** because of reduced power consumption; little sealing water needed; low maintenance cost.

2. **Reduced first cost** because of higher speed operation (600 rpm or more), requiring less costly motors, less expensive foundations and less floor space, because of increased capacity in one pump combination.

3. **Increased reliability** because of improved design and strict adherence to specifications, and selection of materials best fitted to specific needs.

For present or future requirements, you will be interested in details of R-C Vacuum Pumps, given in Bulletin 50-B-13, which will be sent on request.

R-C VACUUM PUMPS

ROOTS-CONNERSVILLE

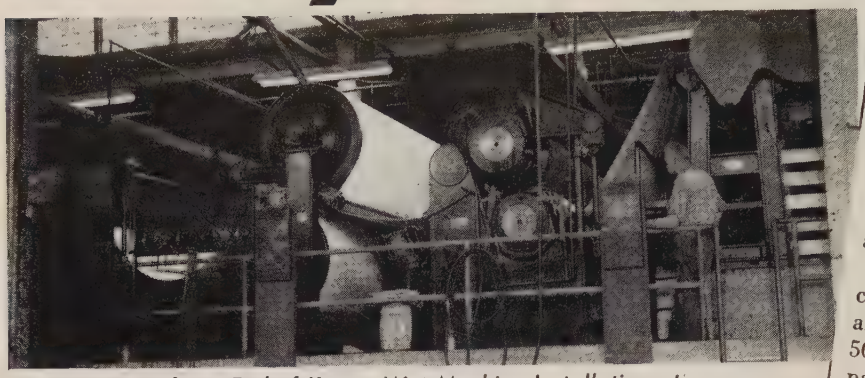
Exclusive Specialists in Handling Gas and Air

ROOTS-CONNERSVILLE BLOWER A DIVISION OF DRESSER INDUSTRIES, INC.
1253 Maple Ave. • Connersville, Indiana

BLOWER BUILDERS R-C SINCE 1854

Reg. T. M.

Higher Yield . . . Drier Pulp . . . in More and More Mills with Kamyr Wet Machines



View of Dry End of Kamyr Wet Machine Installation at Consolidated Water Power & Paper Co., Appleton Division Mill

Consolidated's New Kamyr Wet Machine

Consolidated Water Power & Paper Co. has completed installation of a Kamyr wet machine at its Interlake (Appleton) Division pulp mill at an overall cost of $500,000.

The new two-press 156" feltless machine, built by the Sandy Hill Brass and Iron Works, is designed to produce 50 per cent oven-dry wet lap pulp. Company officials stated that this reduction in moisture content will cut shipping costs and that the machine will increase operating efficiency. All but a small amou[illegible] of pul[illegible]roduced at this loca

Economical and Efficient Pulp Sheeting are chief factors in the current upswing in Kamyr Wet Machine sales.

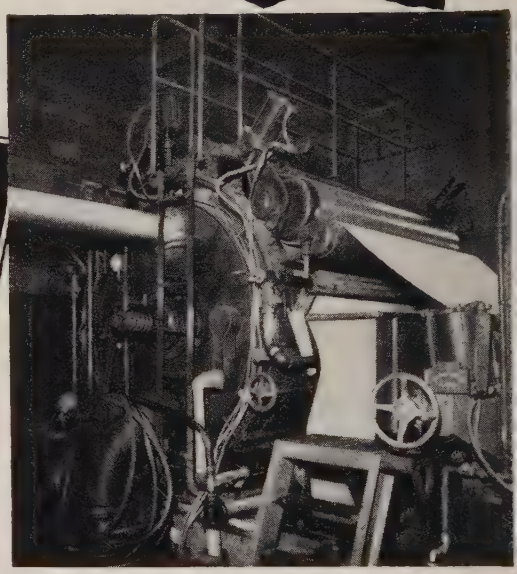
Lower Costs result from:

- Continuous Operation
- Larger Output
- Low Upkeep and Operating Costs
- No Felts
- Long Cylinder Mould Wire Life
- Lower Freight for Drier Pulp

More Efficient Sheeting due to:

- Uniform Consistency
- Greater Dryness
- Cutter Designed for Wet Sheeting
- Sheets of Suitable Size
- Easier Sheet Handling

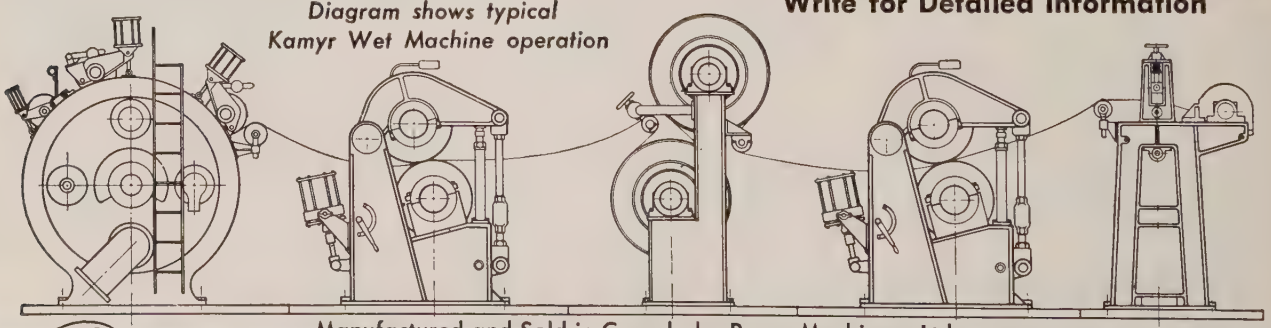
ONE Kamyr Wet Machine regularly replaces 8 to 10 Wet Lap Machines



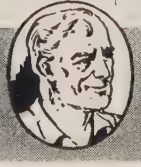
The Mould Section on one of two recently installed Kamyr Wet Machines in mills of International Paper Co.

Write for Detailed Information

Diagram shows typical Kamyr Wet Machine operation

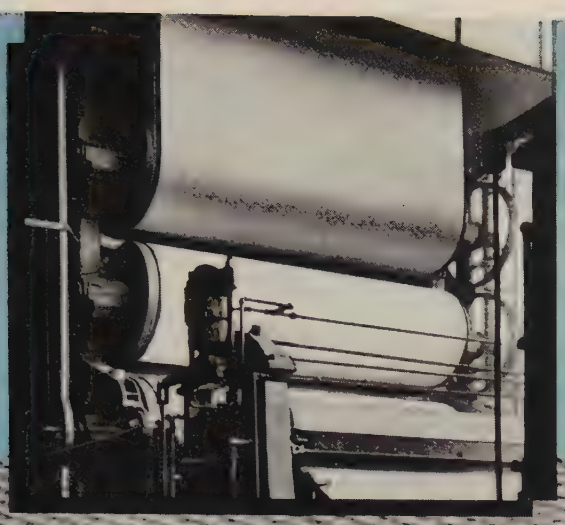


Manufactured and Sold in Canada by Paper Machinery Ltd.



The Sandy Hill Iron & Brass Works

Hudson Falls, N.Y.



SCIENTIFIC CONSTRUCTION* Makes The Big Difference In DRYER FELTS

WOODBERRY 887 REINFORCED DRYER FELT GIVES YOU SCIENTIFIC CONSTRUCTION

Determining Yarn Tensile Strength with 300-lb. vertical test. One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products.

*Asbestos yarns woven into the face of patented Woodberry 887 dryer felts at scientifically determined intervals give you longer wear and smoother operation. Paper mills have learned to count on lowered steam consumption and consistent quality with Woodberry 887. For dryer felts that are low on cost, high on performance, specify Woodberry 887.

Mt. Vernon-Woodberry Mills

Branch Offices: Chicago • Atlanta

TURNER HALSEY COMPANY
Selling Agents
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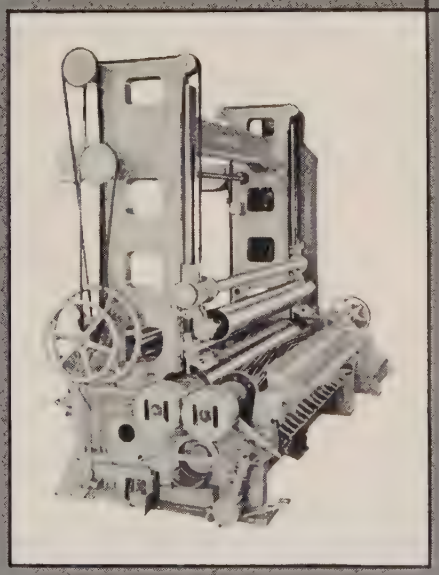
LANGSTON
SLITTERS
AND
WINDERS

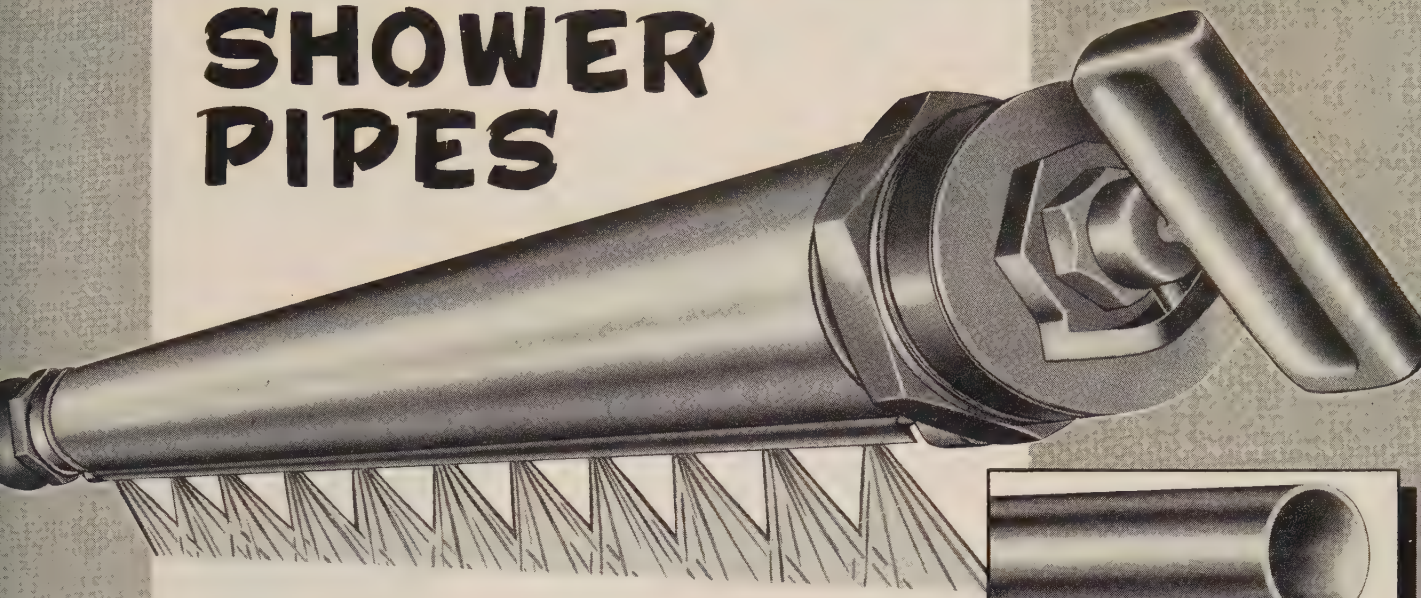


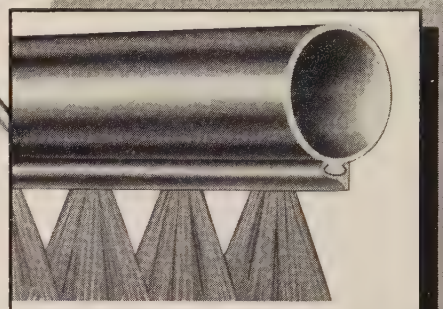
Wherever paper is processed; Mill, Finishing Room or Converting Plant — Langston Slitters & Winders give dependable, trouble-free service.

Samuel M. Langston
Company
CAMDEN 4, NEW JERSEY

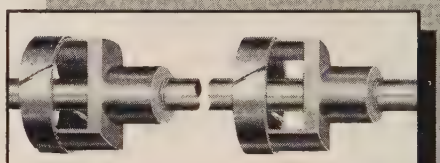
CHIEF SANDUSKY

SHOWER PIPES

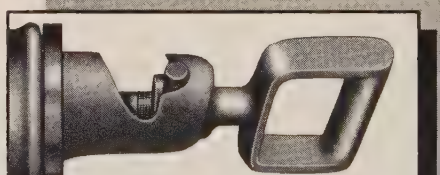




MOVEABLE SPRAY LIP



SLIDING CLEANER RINGS



LOCKING "D" ROD HANDLE

CLEANER VALVE

MADE FOR TOP PERFORMANCE BY MEN WHO KNOW SHOWER PIPE APPLICATION

Simplicity in design. Flexibility in application and service. Freedom from maintenance worries. Highly efficient in performance.

These advantages make "Chief Sandusky" the leading Shower Pipe in the Paper Industry.

Look at the features shown at the right. The famous movable spray lip provides a knife-edge curtain of water with vigorous cleaning action. The sliding bronze cleaner rings, easily operated with the rod handle, quickly remove accumulated waste. The cleaner valve permits easy, effective flushing. After use, the rod handle locks safely in place.

Chief Sandusky Shower Pipes make real savings possible. Many installation expenses are eliminated because no special water supply system, additional pumping facilities or extra filters are required. They can be made for all variations of chemical and fibre content, disposal methods, and water pressure above twenty pounds. They are supplied for all types of machines, for mounting in any position and are built for either fresh or white water operation.

You get these advantages in Chief Sandusky Showers because they are engineered by men who know shower pipe application. They are fitted to machine operation to help improve production performance.

Write for more information on Chief Sandusky Shower Pipes. See how easy it would be to install them and to get their benefits.

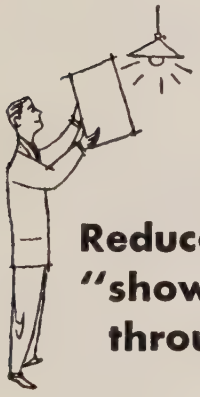
ALWAYS SPECIFY "CHIEF SANDUSKY"

SANDUSKY FOUNDRY AND MACHINE CO

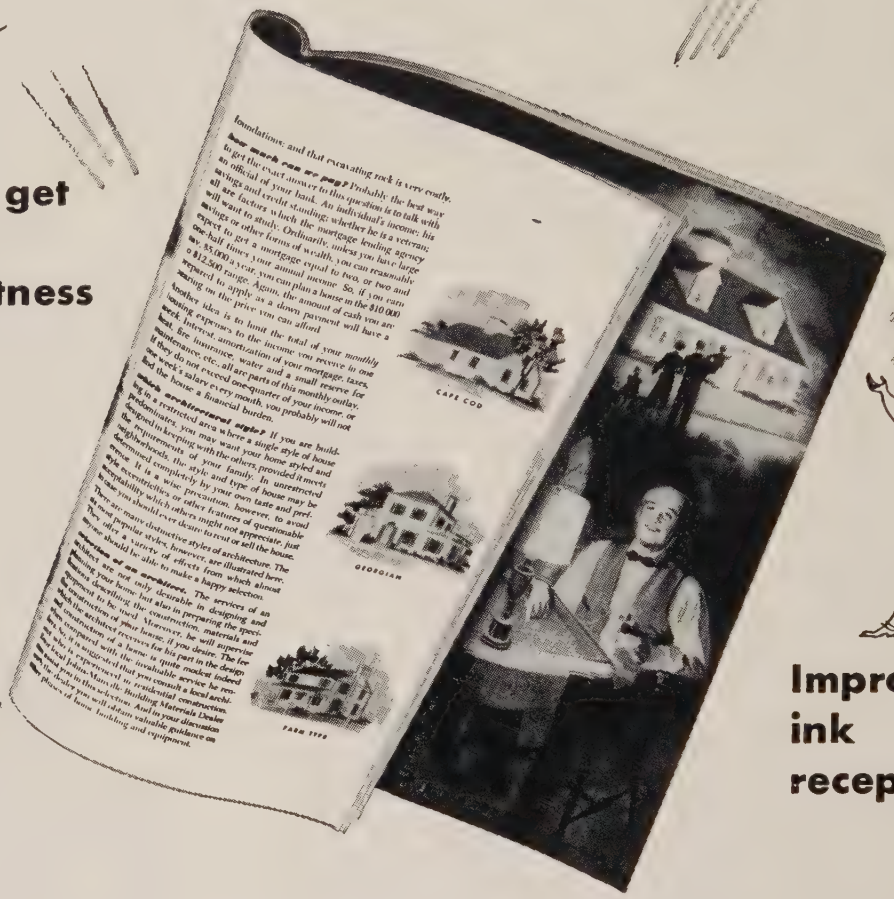
★ ★ ★ SANDUSKY, OHIO, U. S. A. ★ ★ ★

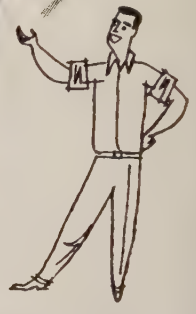
How JM CELITE Johns-Manville helps turn out a better quality sheet...

Helps get high brightness



Reduces "show through"





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Semichemical and High-Yield Chemical Pulping of Hardwoods with Sodium Sulphite and Sodium Bisulphite

R. M. HUSBAND

The acids hydrolyzed from hardwood during digestion facilitate the use of the sodium salts of sulphurous acid in semichemical and high yield chemical pulping of hardwoods. The ratios of the amount of sodium base to the amount of applied sulphur dioxide and to the wood are qualitatively shown to be very important. White birch chips digested with 10% of sodium sulphite (equivalent to 8.4% of sodium carbonate and 2.5% of sulphur) provided 74% of semichemical pulp with improved strength characteristics. These properties were further improved by bleaching in three stages with 16% of chlorine. A pulp of equal chlorine demand but inferior strength properties before and after bleaching was obtained by cooking under the same conditions with 30% of sodium sulphite. A 55% yield of chemical pulp with good strength properties was obtained from birch chips digested with sodium bisulphite equivalent to 14.1% of sodium carbonate and 8.5% of sulphur.

THE semichemical pulping of hardwoods with sodium sulphite is generally conducted in an alkaline medium under conditions that result in neutral or slightly alkaline spent liquors. If sodium sulphite is used as the active chemical, the liquors become acid during the cook unless the ratio of sodium sulphite to wood is relatively large. To neutralize the wood acids generated during the cook and to keep the pH level of the waste liquors above 7, alkaline buffering chemicals are generally incorporated into the fresh liquors. Such additives have been considered necessary to obtain desirable pulp properties as well as to minimize corrosion (*1*, *2*).

Most of the alkaline sodium salts have been considered as buffering agents and their effects on pulp quality have been compared with some species of wood (*1*, *2*). However, the buffer in common use is sodium bicarbonate since the proportion of sodium sulphite to sodium bicarbonate is readily governed by controlling the sulphiting of soda ash. The influence of the ratio of sodium bicarbonate to sodium sulphite has been the subject of several investigations (*3–6*) but there is little agreement on the most satisfactory proportion. H. Bouchayer (*5*) has shown that bright pulps may be obtained even when the pH level of the spent liquors falls to 4.5 so long as the temperature is low enough to avoid burning. However, his interest was focused on brightness and the strength properties of the many pulps were not measured.

In the original procedure of Rue, Wells, Rawling, and Staidl (*1*) the chips were steamed, then impregnated at 125°C., with liquors containing relatively large proportions of chemicals. After impregnation, the excess of liquors, containing much of the acids hydrolyzed from the wood, was removed from the digester so that the ensuing cook was made with quite small proportions of chemicals and low liquor to wood ratios. In general, the consumption of sodium sulphite amounted to between 7 and 15% of the weight of the dry wood together with 4 to 9% of sodium bicarbonate.

Since that time, further investigation of cooking conditions has resulted in pulps for applications other than in coarse papers and paperboard. This change has resulted in an increase in the recommended proportions of chemicals and there is much agreement that neutral sulphite semichemical pulps for high grade uses are best prepared by the consumption of the chemicals resulting from the sulphiting of 18 to 20% of soda ash (*7*, *9*, *10*). For the production of paper-type pulps from birch wood in yields of about 70%, Phelps (*10*) recommends a sodium sulphite to sodium bicarbonate ratio of 4:1 applied under conditions that result in the consumption of 18.9% of soda ash and 4.9% of sulphur on the basis of the dry wood. To prepare 80% yields from mixed hardwoods for use in paperboard, he recommends a 7:1 ratio and the use of 12% of soda ash with 3.3% of sulphur.

In contrast, Daimon and Amino (*4*) have indicated that semichemical pulping of birch was not improved by using more than 10% of soda ash but was improved by high ratios of sodium sulphite to bicarbonate.

Full chemical pulping of hardwoods with sodium sulphite has been subjected to investigation (*11*, *12*, *13*) and several patents (*14*) have been granted. It has been demonstrated that pulps having good physical properties may be obtained from several species of wood in 40 to 50% yields by the use of excessive amounts of chemicals (40 to 88% of the weight of the wood).

For some time now it has been known that acid sulphite pulping of softwoods with sodium base possesses definite advantages over calcium base but these have been insufficient to overcome the greater cost of the sodium base (*15*). The superiority of the latter base is also manifest in the acid sulphite pulping of hardwoods which, being generally dense, offer greater resistance to penetration by chemicals than do softwoods (*16*). Indeed, hardwoods cooked with the sodium base offer useful pulps somewhat deficient in strength properties, particularly in bursting strength.

The purpose of this paper is to show that 70 to 80% yields of semichemical pulps having greatly improved strength characteristics can be prepared from both birch (*Betula papyrifera*) and maple (*Acer saccharum*) woods using not more than 10% of sodium sulphite (equivalent to 8.4% of sodium carbonate and 2.5% of sulphur) as the sole chemical additive. Some preliminary data

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are included to show that even lesser amounts of chemical in the form of sodium bisulphite allow the preparation of semichemical pulps from white birch suitable to many of their present uses. Furthermore, with less soda ash than is usually recommended for semichemical purposes and less than twice the amount of sulphur, a high-yield chemical pulp of low lignin content and quite good strength properties can be prepared.

EXPERIMENTAL

Bark-free logs were cut into $^5/_8$-in. chips in a ten-knife Carthage chipper and screened to remove the fines and oversize pieces. The accepted chips were stored in moistureproof containers pending use. Samples of the chips were dried in an oven at 105°C. so that the weight of dry wood, charged in any cook, would be known.

The chips were cooked in a stainless steel, vertical digester of 1 cu. ft. capacity equipped with an external heat exchanger and circulation system which cycled the liquors at the rate of 2 g.p.m. The liquor to wood ratio was maintained at 4.67 liters per kg. of oven-dry wood. The charged digester was heated to 100°C. in 15 min. and then to the prescribed cooking temperature according to schedule.

At the conclusion of a cook the chips were thoroughly washed in the open digester with hot tap water, then pulped in a 12-in. laboratory Sprout-Waldron disintegrator in a full stream of hot tap water (pH about 8). The pulp was screened through a 12-cut plate and if there was any significant amount of rejects, they were passed through the disintegrator a second time. Excess water was squeezed from the pulp in a fruit press, the cake of pulp weighed, then crumbled and sampled for a moisture determination. The pulp was stored in moistureproof containers.

The strength properties of the pulp were evaluated according to the TAPPI standard beater test. Pulp brightness values were obtained from handsheets of unbeaten pulp, using a Hunter brightness tester with the tristimulus blue filter.

In the majority of the experiments recorded herein, penetration of the chemicals was promoted by evacuating the digester. With the chips in the sealed digester, a Nash-Hytor vacuum pump was used to reduce the pressure in the digester to a gage reading equivalent to 28 to 29 in. of mercury. After this pressure reading had been maintained for 15 min. the liquor charge was pumped into the digester and the valves on the liquor feed line and the aspirator line were closed before the aspirator was shut off. In such experiments the digester was heated to 100°C. in 15 min. and then to the desired cooking temperature in 45 min.

The cooking liquors were prepared from tap water and C.P. sodium sulphite save for those cooks in which technical sodium sulphite (88 to 92% Na_2SO_3) is designated. The sodium bisulphite used in some experiments was U.S.P. grade containing 97% of sodium metabisulphite equivalent to 106% of $NaHSO_3$.

During each cook samples of liquor were withdrawn periodically through a water-cooled condenser. The pH value of these samples was measured at room temperature and their content of reducing chemicals determined iodometrically.

The amounts of lignin and pentosans in the pulps and the lignin content of the woods were determined according to TAPPI Standard procedures. The pentosan content of the woods was determined according to the TAPPI Standard procedure for pentosans in pulp. Most of the birch wood was from one lot which contained 17.9% of lignin and 24.7% of pentosans. Two of the digestions (CIB9 and CIB10) were made on another lot of birch wood that contained 18.6% of lignin and 22.2% of pentosans. The maple wood contained 20.0% of lignin and 22.4% of pentosans.

DISCUSSION OF RESULTS

The data of Table I show that semichemical pulps of good strength qualities can be prepared from white birch chips digested with no more than 11% of sodium sulphite (equivalent to 9% of sodium carbonate) at 173°C. for 2 to 4 hr. and without the addition of other chemicals to neutralize the wood acids. Extension of the digestion period to 6 hr. removed very little more lignin, did not deteriorate the strength properties, but drastically reduced the yield of pulp and its brightness. Indeed, when brightness is of little concern, pulps having comparable strength properties can be prepared with as little as 3.3% of sodium sulphite (2.8% of sodium carbonate; cooks nos. 84 and 87).

Two comparable digestions (CIB9 and CIB10) were made with sodium sulphite equivalent to 19% of sodium carbonate and these clearly show that there is little

Table I. Cooking Conditions and Properties of Pulps Prepared with Sodium Sulphite[a]

	Cooking conditions						Pulp yield, lb./100 lb. O.D. wood	Pulp brightness (Hunter), %	Pulp lignin content, %	Pulp strength properties: Bursting strength, pt./lb./ream at C.S. freeness 500 ml.	Bursting strength, pt./lb./ream at C.S. freeness 300 ml.	Tearing strength, g./lb./ream at C.S. freeness 500 ml.	Tearing strength, g./lb./ream at C.S. freeness 300 ml.	Beating time to C.S. freeness 500 ml.	Beating time to C.S. freeness 300 ml.
Cook No.	Chemical charged, Na_2SO_3, lb./100 lb. O.D. wood	Na_2SO_3 content waste liquors, g./l.	Time to max. temp., hr.	Time at max. temp., hr.	Max. temp., °C.	pH value spent liquor									
						Birch									
78	10.7	3.5	2	2	173	5.21	70.7	45	11.6	0.75	1.13	1.05	0.87	34	56
83	10.7	2.4	2	4	173	5.40	69.6	37	11.1	0.62	1.10	1.34	1.22	15	40
85	12.0	3.6	2	6	173	4.62	57.9	18	13.0	0.65	1.09	1.45	1.21	12	37
84	6.18	1.7	2 0.33	3 0.5	150 173	4.60	66.2	31	14.2	0.76	1.17	1.33	1.03	30	62
87	3.33	1.5	2 1	... 1	150 160	4.50	72.2	28	14.1	0.65	1.13	1.26	1.00	58	90
CIB9	22.1	28.5	1.5	2	173	6.65	68.8	45	9.6	0.90	1.25	1.20	0.97	27	43
CIB10	22.6	22.8	1.5	3.5	173	6.70	67.6	46	8.6	0.85	1.10	1.07	0.85	25	30
						Maple									
CIM4	22.3	30.0	1.5	2	173	6.59	72.1	48	9.9	0.81	1.00	1.24	1.03	28	44
CIM5	10.5	7.2	2	2	173	5.60	70.2	39[b]	11.2	0.70	1.13	1.19	1.08	32	51

[a] Technical Grade Na_2SO_3.
[b] The low brightness is due to a slight burning of the chip centers.

Table II. Cooking Conditions and Chemical Analysis of Pulps Prepared with Different Ratios of Base to SO_2[a]

Cook No.	Cooking conditions: Max. temp., °C.	Time at max. temp., hr.	Chemicals added, lb./100 lb. wood: Na_2SO_3	$NaHSO_3$	Spent liquors: Residual chemical, g./l. as SO_2	pH	Pulp yield lb./100 lb. wood	Lignin content, % of pulp	Pentosan content, % of pulp	Lignin removed, % of O.D. wood	Pentosan removed % of O.D. wood
89	160	4	10.0	..	1.9	4.80	73.5	11.3	20.9	9.6	9.4
90	160	4	5.0	4.1	1.7	4.35	67.5	11.0	17.3	10.5	13.0
91	160	4	...	8.2	3.3	3.11	58.4	12.7	13.0	10.5	17.1
96	150	4	9.8	..	5.0	5.05	79.6	12.2	24.5	8.2	5.2
97	150	4	4.8	4.15	4.2	4.77	75.0	11.9	23.7	8.9	6.9
98	150	4	...	7.9	1.4	3.52	62.8	11.0	18.7	11.0	13.0
110	140	4	...	7.9	4.0	3.52	76.1	12.5	20.4	8.4	9.2
93	160	4	29.7	...	26.2	6.54	77.6	10.3	26.7	9.9	4.0
92	160	4	15.2	12.1	22.8	5.21	73.9	9.9	23.9	10.6	7.1
102	160	4	...	24.1	10.1	3.36	55.8	4.6	15.7	15.3	15.9
95	160	4	...	27.6	11.6	3.50	55.3	3.6	16.2	15.9	15.7
99	160	4	...	16.3	3.3	3.35	52.6	6.6	16.2	14.4	16.2
100	150	4	...	16.4	9.9	3.47	64.0	8.9	19.8	12.2	12.0
101	160	3	...	16.3	6.0	3.46	58.5	7.6	17.0	13.5	15.5
108	160	6	...	25.1	3.7	3.42	48.1	2.6	12.8	16.6	18.5
109	160	4	....	27.2	8.5	3.40	51.9	3.3	13.0	16.2	17.9

[a] All of the cooks recorded in this table were made with pre-evacuation of the digester.

advantage in the use of more sodium sulphite. It is true that the greater quantity of sodium sulphite removed more lignin, however, it is equally clear that extensive removal of the lignin is not essential to the development of good strength properties.

Much the same results were obtained with maple wood chips digested with 22% (CIM4) and 10% (CIM5) of sodium sulphite. The lower brightness of the latter pulp is due to a slight burning of the chip centers. Such burning can be overcome by any technique that allows more uniform penetration of the cooking chemicals into the wood chips.

The pulps whose properties are presented in Table III resulted from cooking according to the conditions detailed in Table II. In each of these experiments the digester was evacuated before the liquor charge was added, to facilitate penetration of the chemicals.

The physical properties of the pulp digested with 10% of sodium sulphite (no. 89) are markedly superior to those recorded in the literature of the neutral sulphite pulping of white birch wood (*1*, *7*). More significantly, they are superior to the physical properties of the pulps from any of 15 neutral sulphite digestions made upon the same lot of wood (*8*). These latter digestions were made at 173°C. in three series, with 20, 15, and 10% of sodium sulphite (expressed as Na_2CO_3) and sufficient sodium bicarbonate to make the ratio of sodium sulphite (as Na_2CO_3) to sodium bicarbonate (as Na_2CO_3) 6:1, 4:1, 3:1, 2:1, and 1:1 in each series of digestions. The pulps with the best physical properties were obtained in 61 to 66% yields in the series made with 20% of sodium sulphite (as Na_2CO_3) and their strength properties were not markedly affected by the ratio of sodium sulphite to sodium bicarbonate.

Useful semichemical pulps may be prepared with still smaller amounts of chemicals in the form of sodium bisulphite (cooks nos. 90, 97, 98, and 110) however, the time and/or the temperature of digestion must be reduced if drastic acid hydrolysis and low yields of burned pulp are to be avoided.

A comparison of the cooks nos. 89 and 93 or of 90 and 92 reveals that tripling the amount of sodium sulphite or of 50/50 sodium sulphite and sodium bisulphite mixture does not remove appreciably more lignin, allows the retention of greater amounts of pentosans, yet results in pulps of markedly inferior strength properties. Thus it seems clear that there is no advantage in digesting white birch wood with appreciably more than 10% of sodium sulphite under the prescribed conditions.

The bleaching data for pulps 89 and 93 (Table IV) strengthen this conclusion. The pulp prepared with the greater amount of sodium sulphite (no. 93) consumed very little less chlorine and sodium hydroxide during bleaching to 79% brightness and provided slightly more

Table III. Physical Properties of Pulps Prepared with Different Ratios of Base to SO_2[a]

Cook No.	Yield, lb./100 lb. wood	Brightness (Hunter), %	Classification: Intermediates, %	Through 150 mesh, %	Pulp strength properties: Bursting strength, pt./lb./ream at C.S. freeness 500 ml.	Bursting strength, pt./lb./ream at C.S. freeness 300 ml.	Tearing strength, g./lb./ream at C.S. freeness 500 ml.	Tearing strength, g./lb./ream at C.S. freeness 300 ml.	Beating time to C.S. freeness 500 ml.	Beating time to C.S. freeness 300 ml.
89	73.5	43[b]	67	7.8	0.90	1.30	1.44	1.18	38	67
90	67.5	36	66	9.8	0.92	1.30	1.37	1.24	29	55
91	58.4	21	73	13.8	0.58	0.98	1.23	1.07	4	19
96	79.6	50	70	7.7	0.62	1.00	1.19	1.00	41	75
97	75.0	45	71	7.8	0.66	1.03	1.14	0.95	51	83
98	62.8	31	79	9.6	0.79	1.16	1.15	0.94	9	28
110	76.1	45	70	9.4	0.54	0.86	1.14	1.03	32	57
93	77.6	53	62	12.5	0.81	1.13	1.10	0.89	12	32
92	73.9	53	63	15.1	0.88	1.29	1.21	0.96	17	40
102	55.8	50	75	6.3	0.90	1.13	1.28	1.02	12	27
95	55.3	54[c]	90	7.7	1.27	1.47	1.44	1.21	10	21
99	52.6	32	91	8.3	0.98	1.20	1.31	1.05	11	23
100	64.0	42	69	17.4	0.79	1.10	1.22	1.05	8	26
101	58.5	42	80	8.3	0.85	1.17	1.26	1.09	14	27
108	48.1	49	87	13.4	0.69	1.14	1.16	0.93	2	15
109	51.9	51	85	10.4	0.92	1.23	1.22	1.17	7	16

[a] All of the cooks recorded in this table were made with pre-evacuation of the digester.
[b] This pulp was much brighter but darkened during disintegration in water of pH 8.
[c] This pulp was brighter. The figure is in error due to markings placed in the center of the sheet.

bleached pulp. Its strength properties, though improved by bleaching, remain distinctly inferior to those of pulp 89.

The Importance of the Wood Acids to Pulping with Sulphurous Acid Salts; Their Role in Lignin and Pentosan Removal

While the chemical charged in many of these experiments has been sodium sulphite, it is clear from the pH changes accompanying the cooking schedule as well as

Table IV. Bleaching Data for Pulps 89 and 93[a]

	Pulp 89	*Pulp 93*
Digested with Na_2SO_3, %	10.0	29.7
1st stage—Chlorination (3%, 70°F.)		
Chlorine added, % (Cl_2-water)	14.7	13.4
Chlorine consumed, %	14.6	13.3
Yield, %	94.4	93.3
2nd stage—Caustic extraction (12%, 160°F.)		
NaOH added, %	5.5	5.0
NaOH consumed, %	5.3	3.8
Yield, %	86.8	86.6
3rd stage—Hypochlorite (12%, 100°F.)		
NaOH added, %	1.01	1.34
Chlorine added, % (NaOCl)	2.0	3.3
Chlorine consumed, %	1.5	2.0
Yield, %	99.2	98.2
Over-all bleaching yield, %	81.3	79.4
Yield of bleached pulp (% basis O.D. wood)	59.8	61.6
Total chlorine consumed, %	16.1	15.3
Bleached pulp brightness (Hunter), %	79.8	78.1
Bleached pulp strength properties		
At 500 ml. C.S. freeness		
Bursting strength, pt./lb./ream	1.53	1.04
Tearing strength, g./lb./ream	1.46	0.94
At 300 ml. C.S. freeness		
Bursting strength, pt./lb./ream	1.68	1.37
Tearing strength, g./lb./ream	1.15	0.83

[a] Percentages based on unbleached pulp.

from the thorough work of Ross, Hart, Strapp, and Yean (*17*) that the active chemical must be sodium bisulphite created through the agency of the wood acids. The pH level of cook no. 89 was 6.21 when the cooking temperature of 160°C. was first reached and fell to 5.19, 4.95, 4.89, and 4.80 during subsequent hourly intervals. In cook no. 96 at 150°C. the pH level fell from 7.08 to 6.50, 5.50, 5.24, 5.14, and 5.05 during the course of the cook. These and similar data from other cooks are all in agreement with the statement of Rawling and Staidl (*18*) that the amount of acids created is a function of time and temperature. In contrast, Keller and McGovern (*2*) have stated that the formation of the wood acids is complete within a short time at 120°C.

It is now well known that the sulphonation of wood proceeds even in alkaline sulphite solutions but becomes more extensive as the pH level of the solutions fall toward pH 1 (*19*). Hence, it may be realized that when wood is heated with solutions of sodium sulphite, the pH level will fall as more of the wood acids are liberated and sulphonation will become more extensive. The lignin sulphonic acids so formed can bind, by ion exchange, but one of the two sodium ions provided by the sodium sulphite molecule. It is therefore conceivable that with a proper choice of temperature and ratio of sodium sulphite to the species of wood, sulphonation could become more extensive than the liberation of the wood acids in which event the pH level would pass through a minimum and rise thereafter. The presence of alkaline buffers would serve to diminish the effective amount of wood acids by neutralization. Indeed, in "neutral sulphite" cooks buffered with sodium bicarbonate, the pH value often passes through a minimum and then rises toward the end of the cook. When sodium sulphite alone is used in the cook, this effect can be noticed only when the amount of sodium sulphite is large, approaching, in the case of birch, 30% of the weight of the wood, and then the rise in pH level is slight.

These considerations serve to point out the important role of the wood acids and the realization that in cooking with sulphurous acid salts the ratios of the sodium base to the sulphur dioxide and to the amount of wood acids are very important. Unfortunately, no convenient method has yet been elaborated for determining the amount of wood acids generated during cooking with solutions of sulphurous acid salts.

Among the experiments recorded in Table II, several (89 to 91, 96 to 98 and 110) were made with 5% of sulphur dioxide combined with different amounts of sodium in sodium sulphite, sodium bisulphite, or a 50/50 mixture of the two. Another such series of experiments was made with amounts of these salts equivalent to 15% of sulphur dioxide (93, 92, 102, and 108). Still other experiments were made with sodium bisulphite alone equivalent to 10% (99, 100, 101) and 17% of sulphur dioxide (95, 109).

The different amounts of lignin and pentosans removed from white birch wood in these experiments are recorded in Table II. The pH values of the spent liquors are plotted against the amounts of lignin removed from the wood in Fig. 1 and against the amounts of pentosans removed in Fig. 2.

An examination of Fig. 1 reveals that so long as the pH level of the spent liquors remains above about pH 3.5 then the removal of lignin is related to the temperature of the cook and the pH value of the liquors. When sulphur dioxide equivalent to 5% of the weight of the wood is applied as sodium sulphite and/or sodium bisulphite, the pH value of the spent liquors falls and more lignin is removed* at 150 or 160°C. as sodium sulphite is replaced with sodium bisulphite; that is as the proportion of base to sulphur dioxide and to the wood acids decreases. This same statement is true for experiments made with salts equivalent in sulphur dioxide to 15% of the weight of the wood.

Table V. pH History of Cooks 95 and 109

Time, hr.	*Cook no. 95, pH*	*Cook no. 109, pH*
0	4.57	4.48
0.5	4.62	4.20
1.0	4.32	3.98
2.0	3.92	3.67
3.0	3.66	3.51
4.0	3.56	3.41
5.0	3.50	3.40

It can be realized from Fig. 1 that for any fixed spent liquor pH value between 4 and 6.5, more lignin can be removed by the application of 15% rather than 5% of sulphur dioxide. However, this result cannot be accomplished by tripling the amount of sodium sulphite

* Cook no. 91 was badly burned and must be put aside from this consideration. The lignin content of burned pulps appears to be disproportionately high. Presumably lignin fragments that were solubilized, or those already sulphonated and about to be solubilized, are so altered that they are precipitated from solution or otherwise are not removed.

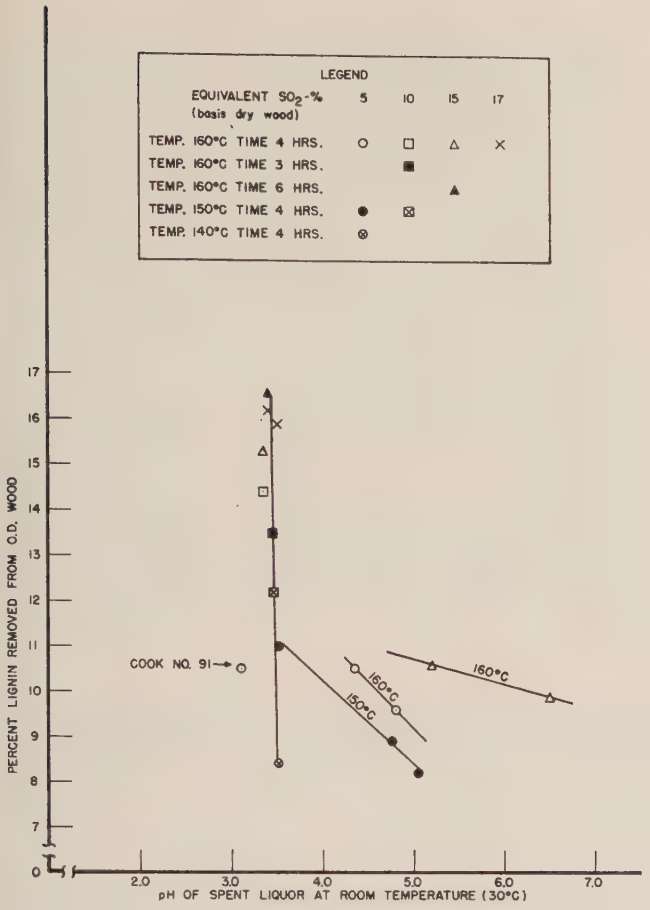
LEGEND
EQUIVALENT SO_2-% (basis dry wood) 5 10 15 17
TEMP. 160°C TIME 4 HRS.
TEMP. 160°C TIME 3 HRS.
TEMP. 160°C TIME 6 HRS.
TEMP. 150°C TIME 4 HRS.
TEMP. 140°C TIME 4 HRS.
COOK NO. 91
160°C
150°C
PERCENT LIGNIN REMOVED FROM O.D. WOOD
pH OF SPENT LIQUOR AT ROOM TEMPERATURE (30°C)

Fig. 1. Lignin removal versus the pH of the spent liquors

or of the amount of 50/50 sodium sulphite-sodium bisulphite mixture because the ratio of the sodium base to the wood acids is increased simultaneously with the increase in the ratio of sulphur dioxide to the wood.

In contrast, the removal of pentosans from cooks confined to the pH range 4 to 6.5 (Fig. 2) is dependent only upon temperature and the pH of the liquors, and is independent of the concentration of sulphur dioxide. Of course the duration of the cook, that is, time is another variable not reflected in this portion of the graph.

When the ratio of sodium base to the sulphur dioxide in the applied chemicals is reduced to that in sodium bisulphite, the cooking liquors become buffered about pH 3.4 to 3.5 during the digestion. Under these conditions the removal of lignin is conditioned (Fig. 1) by the duration of the cook, temperature, and the concentration of bisulphite, whereas the removal of pentosans is independent of the concentration of bisulphite.

It is important to recall at this point that when the applied chemical is sodium bisulphite, the process of sulphonation, *per se*, cannot appreciably affect the pH value of the liquors since each bisulphite ion that is converted to a sulphonic acid group will bind its accompanying sodium ion. However, so long as sodium bisulphite is being consumed in this manner while the wood acids continue to be set free, then the buffer system will tend toward its more acid limit. In this light, the cook no. 91, which was badly burned, is instructive. The amount of sodium bisulphite applied (8.2%) was so small that the liquor was acidified to pH 3.5 within an hour after the maximum temperature (160°C.) had been reached. Within the next hour, the liquor was essentially depleted of bisulphite, and the buffer system destroyed. As a result, the pH level of the liquor fell, and the incompletely sulphonated lignin was apparently so altered that its removal ceased though the hydrolysis of the pentosans continued.

The rate at which the wood acids are generated, the rate of sulphonation of the lignin, and the rates of hydrolysis of the sulphonated lignin and the hemicelluloses are obviously critical to pulping under the described conditions and must be determined. However, in the absence of such fundamental knowledge, the experiments 95 and 109 clearly show that conditions can be prescribed to allow the preparation of chemical pulps from birch wood.

Pulp 95 and pulp 109 were prepared under identical conditions of time and temperature with essentially the same amounts of sodium bisulphite. However, the former digestion contained in addition, a very small amount of sodium sulphite—sodium carbonate solution accidentally left in the liquor feed line from the preceding experiment. As a result, the pH history of the two cooking liquors differed (Table V) and pulp 109 was digested at pH 3.5 to 3.4 for 2 hr. more than pulp 95. The latter pulp, obtained in 55% yield contained 3.5% of lignin and had very good strength properties. Pulp 109 contained very little less lignin but, as a result of the longer digestion at pH 3.4 to 3.5, considerably less pentosans. It developed strength properties comparable to those obtained by acid sulphite processing of birch wood (*16*) which, however, are distinctly inferior to the strength properties of pulp 95.

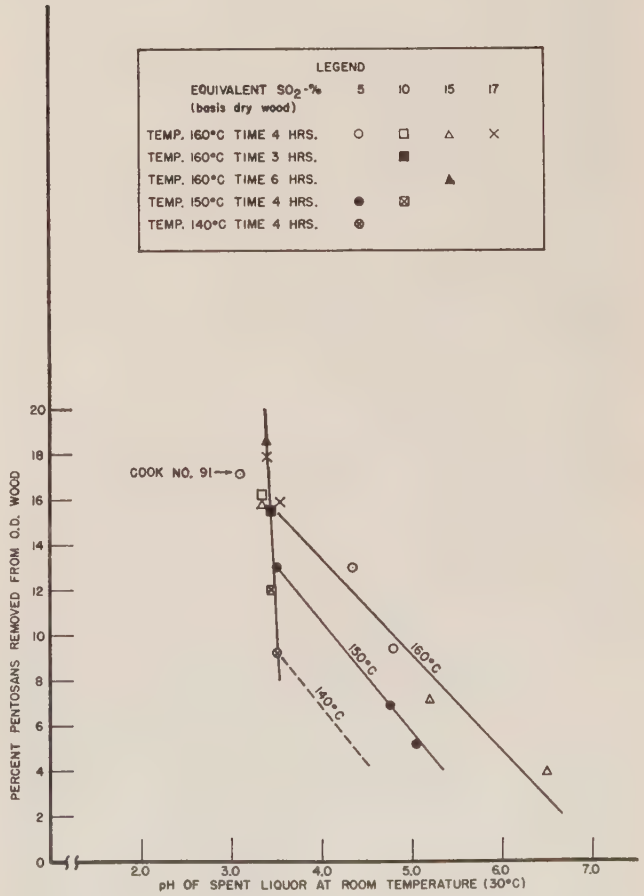
LEGEND
EQUIVALENT SO_2-% (basis dry wood) 5 10 15 17
TEMP. 160°C TIME 4 HRS.
TEMP. 160°C TIME 3 HRS.
TEMP. 160°C TIME 6 HRS.
TEMP. 150°C TIME 4 HRS.
TEMP. 140°C TIME 4 HRS.
COOK NO. 91
160°C
150°C
140°C
PERCENT PENTOSANS REMOVED FROM O.D. WOOD
pH OF SPENT LIQUOR AT ROOM TEMPERATURE (30°C)

Fig. 2. Pentosan removal versus the pH of the spent liquors

The pulping of hardwoods with sulphurous acid salts is presently being pursued in greater detail and will be the subject of future communications.

LITERATURE CITED

1. Rue, J. D., Wells, S. D., Rawling, F. G., and Staidl, J. A., *Paper Trade J.* 83, No. 13: 50–53 (Sept. 23, 1926).
2. Keller, E. L., and McGovern, J. N., *Tappi* 32, No. 9: 400–405 (1949).
3. Bray, M. W., and Eastwood, P. R., *Paper Trade J.* 90, No. 25: 57–60 (June 19, 1930).
4. Daimon, T., and Amino, Y., *J. Japan. Tech. Assoc. Pulp Paper Ind.* 5, 104–107 (1951); *C. A.* 45: 10577i (1951).
5. Bouchayer, H., *Ann. inst. polytech., Grenoble* 155–164 (1952); *C. A.* 46, 9303f (1952).
6. Libby, C. E., and O'Neil, F. W., *Tappi* 33, No. 4: 161–178 (1950).
7. MacLaurin, D. J., Peckham, J. R., and Weber, W. B., *Tappi* (in press). Paper presented at the 38th Annual Meeting TAPPI, Feb. 18, 1953.
8. Empire State Paper Research Associates, Inc., Progress Report No. 5B, Unpublished data.
9. Murtfeldt, L. W., *Pulp and Paper* 24, No. 9: 38–44 (Aug., 1950).
10. Phelps, M. W., *Northeastern Wood Utilization Council Bull.* No. 14: 59–70 (Jan., 1947).
11. Chidester, G. H., and McGovern, J. N., *Paper Trade J.* 108, No. 6: 31–32 (Feb. 9, 1939).
12. McGovern, J. N., and Keller, E. L., *Pulp Paper Mag. Can.* 49, No. 9: 93–100 (Aug., 1948).
13. Aronovsky, S. I., and Gortner, R. A., *Ind. Eng. Chem.* 25: 1349–1354 (1933).
14. Sutermeister, E., "Chemistry of Pulp and Paper Making," 3rd ed., page 255, New York, John Wiley & Sons, 1948.
15. Chidester, G. H., *Paper Trade J.* 104, No. 6: 39–42 (Feb. 11, 1937).
16. Richter, G. A., *Ind. Eng. Chem.* 33: 532–538 (1941).
17. Ross, J. H., Hart, J. S., Strapp, R. K., and Yean, W. Q., *Pulp Paper Mag. Can.* 52, 116–122 (Sept., 1951).
18. Rawling, F. G., and Staidl, J. A., *Paper Trade J.* 81, No. 8: 49–51 (Aug. 20, 1925).
19. Hägglund, E., "Chemistry of Wood," page 196, New York, Academic Press, Inc., 1951.

Presented at the Annual Meeting of the Empire State Section of the Technical Association of the Pulp and Paper Industry, Whiteface, N. Y., June 9, 1953.

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Hemicelluloses and Arabogalactans as Beater Adhesives

JAMES O. THOMPSON, JOHN W. SWANSON, and LOUIS E. WISE

Representative and degraded hemicellulose fractions from aspen, black spruce, Douglas-fir, and slash pine have been examined as beater adhesives. The softwood hemicelluloses were found to be superior to those of the hardwood in improving the strength properties of handsheets—those of higher mannan (hexosan) content being the more effective. The magnitude of the strength improvements obtained with the higher mannan contents was about the same as that obtained with locust bean gum. Severe hydrolytic degradation of the hemicelluloses caused a marked reduction in adhesive strength. This indicated the existence of a critical minimum degree of polymerization. The factors influencing the effectiveness of hemicelluloses as beater adhesives are discussed. Similar experiments with arabogalactans from western larch, black spruce, and Douglas-fir showed that these highly branched polysaccharides did not contribute to sheet strength.

The influence of hemicelluloses on the strength properties of papers made from wood pulp fibers has been the subject of considerable study during the past few years. Workers in the field include Young and Rowland (*1*), Jonas and Rieth (*2*), Obermanns (*3*), Houtz and Kurth (*4*), Jayme, *et al.* (*5–9*), March (*10*), Ratliff (*11*), Fineman (*12*) and Khinchin (*12a*). The subject has been discussed in some detail in recent reviews by Ross (*13*) and Cottrall (*14*). Most of the work reported has been concerned with the relationship between the amount of the hemicelluloses retained in pulps, the rate of beating and the strength properties of the pulps. In general, those pulps which contain the higher concentrations of hemicelluloses, up to a certain maximum, have been found to beat faster and to develop greater strength than corresponding pulps containing lower concentrations. A few studies have been reported in which isolated hemicelluloses have been examined as beater adhesives. Jonas and Rieth (*2*) showed that an increase in strength resulted when a xylan and a mannan isolated from a spruce sulphite pulp were employed as beater adhesives; the mannan was more effective than the xylan. Obermanns (*3*) isolated a xylan from a soda pulp, added this to rag, sulphite, and alpha pulps in the beater, and found that the rate of beating and strength properties were improved. March (*10*) added dry aspen hemicelluloses to aspen pulps in the beater and found that the addition of small amounts improved the bursting strength, but that the addition of large amounts did not produce strength improvement.

The variable which has been emphasized in these earlier studies has been the *amount* rather than the *quality* of the hemicelluloses retained. Little attention has been given to the significance of the differences in chemical constitution of the hemicelluloses from the different wood species and to the significance of differences in the chain length or degree of polymerization of the hemicelluloses.

The desirability of further investigations into the role of hemicelluloses in this vitally important field of fiber bonding has recently been emphasized by Forman (*15*):

> "One of the greatest unknowns seems to lie in the realm of hemicelluloses. . . . the lack of information relating to the hemicelluloses appears to be outstanding—and (much more work is) essential to solution of the fiber bonding question."

and by Cottrall (*14*):

> ". . . further investigations to determine the changes, not only in the quantities, but also in the nature and compositions of the different hemicelluloses remaining in the pulp after the wood has been treated with the various reagents, especially the liquors normally used for pulping, would be very revealing, particularly if these results were related to the papermaking properties of the pulps."

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The chemistry of the hemicelluloses has been discussed by Wise (*16*) who points out that the monomeric sugar unit which normally predominates in all hemicelluloses is the pentose xylose, and that the hemicelluloses of the softwoods differ from those of the hardwoods in that they contain appreciable percentages of the hexose unit mannose. Other sugar units such as rhamnose, arabinose, galactose, and glucose are also often present in smaller amounts. In addition to these various sugar units, uronic anhydride units are also generally present in significant amounts. The presence of appreciable percentages of mannose and other hexose units in the hemicelluloses of the softwoods suggests that perhaps these hemicelluloses may be expected to contribute to paper strength to a degree differing from that obtained with those of the hardwoods which are almost completely free of hexose units. Further, the degree of polymerization or chain length of isolated hemicelluloses (or of those retained in pulps) is almost certainly a function of the chemical treatment to which the parent plant tissue has been subjected in the isolation of the hemicelluloses (or in the preparation of the pulp). Hemicelluloses isolated under mild conditions from wheat straw, beech, spruce, paper birch, and aspen have essentially the same number average degree of polymerization, viz., 155 (*17*). The degree of polymerization is less, however, when the method of preparation is more drastic (*18*, *19*), or when the isolated hemicellulose is subjected to some degradative influence (*17*). Highly degraded hemicellulose fractions would be expected to influence paper strength to an extent differing from that of representative undegraded fractions.

The present paper describes the results of an orienting investigation in which representative and degraded hemicellulose fractions isolated from both hard and softwoods have been used as beater adhesives. The primary object of the work was to determine in a preliminary manner the extent to which differences in chemical structure and chain length of the hemicelluloses influence their adhesive properties, and thus to provide a basis for more detailed studies. The results obtained from similar experiments with arabogalactans are also described.

PART I. FACTORS INFLUENCING THE EFFECTIVENESS OF HEMICELLULOSES AS BEATER ADHESIVES

Hemicelluloses are generally regarded as contributing to paper strength by virtue of their ability to improve the bonding between cellulose fibers—that is, they serve as interfiber adhesives. On the basis of this premise, a number of factors appear to be of importance in determining the extent to which hemicelluloses may contribute to the strength of a sheet when employed as beater adhesives. These include: (1) the strength of the adhesive bonds between the cellulose and the hemicellulose, (2) the chain length or degree of polymerization and the degree of branching of the hemicelluloses, and (3) the strength of the cohesive bonds between hemicellulose molecules.

It will be clear that, for the hemicellulose molecules to be effective in improving fiber-to-fiber bonding, they must first be sorbed onto the surface of the cellulose fibers. The kind of bond involved in this specific adhesion is of the secondary valence hydrogen bond type

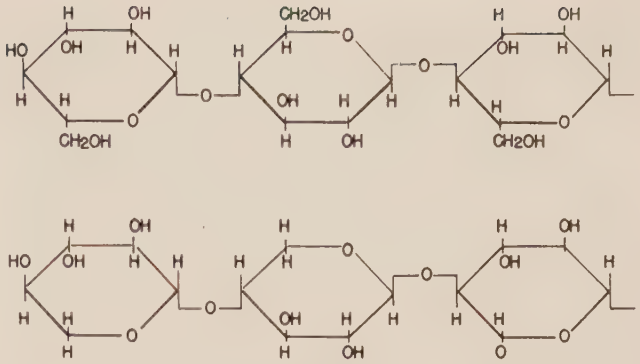

Fig. 1. Diagrammatic representation of a hexosan and a pentosan

(a) (top) Cellulose chain—hexose units. (b) (bottom) Xylan chain—pentose units.

between the highly polar hydroxyl groups of the hemicellulose molecules and those on the surface of the fiber. Cellulose fibers consist essentially of linear polymers made up of glucose units (Fig. 1a). Each of these hexose sugar units has *three* hydroxyl groups capable of taking part in hydrogen bonding and, indeed, these hydroxyls are responsible for intermolecular bonding within the fiber. Clearly the hydroxyl bonds on the surface of the fiber which are not taking part in this intermolecular bonding will be available for potential interfiber linkages. It should be noted that two of the hydroxyls of a hexose are secondary and the third is primary. Hemicelluloses, on the other hand, consist mainly of xylose units (Fig. 1b). These are pentose sugar units and differ from the hexoses in that they have but *two* hydroxyl groups available for hydrogen bonding and both of these hydroxyls are secondary. The hemicelluloses from softwoods, as mentioned above, contain appreciable amounts of mannose and other hexose units, however, and because the hexoses have a primary hydroxyl not possessed by the pentoses it seems reasonable to believe that the softwood hemicelluloses should possess a definite advantage in the degree to which they can contribute to both adhesive and cohesive strength. This advantage should accrue not only from the higher concentration of hydroxyls per unit chain length (higher cohesive energy density) but also from the fact that the primary hydroxyls possess a mobility not possessed by the secondary hydroxyls and thus make possible bonds which would be impossible otherwise for steric reasons. Superimposed upon this major distinction between pentose and hexose units are the relatively minor configurational differences which exist among the various hexose (and pentose) units, and which serve to distinguish them from one another. On first consideration it would seem that the influence of these latter differences on adhesive properties should be small compared with the influence of the more distinct difference between the broader classification of pentoses and hexoses. This is assumed in the present study. A more detailed investigation might include an experimental assessment of this assumption. The presence of the carboxyl groups of the uronic anhydride residues would also be expected to influence the adhesive and cohesive properties of the various hemicellulose fractions.

The degree of polymerization or chain length of the hemicelluloses is important for at least two reasons. In that case when a single hemicellulose molecule

serves to bond two cellulose fibrils together, a minimum degree of polymerization will clearly be required in order for the chain molecule to bridge the distance between the two fibrils. Degraded hemicelluloses of low degrees of polymerization would thus be expected to be at a disadvantage as compared with undegraded hemicelluloses. The degree of polymerization will also be important when the bonding distance between two cellulose fibrils is such that a film or strand of the hemicellulose is required rather than a single molecule. In this case the strength of the bonding film or strand will depend on both the degree of polymerization and the cohesive strength of the hemicelluloses. Before any linear polymer can show appreciable mechanical strength a certain minimum degree of polymerization must be reached and this minimum varies inversely with the cohesive force between the polymer molecules (*20*). This minimum degree of polymerization ranges from about 40 for the highly polar amides (high cohesive forces) to about 80 for the nonpolar hydrocarbons (low cohesive forces). On this basis, the critical minimum for the hardwood hemicelluloses, which consist chiefly of xylose units, would be expected to be higher than for the mannose-containing hemicelluloses of the softwoods. In practice, of course, the picture is complicated by the fact that representative hemicellulose fractions are not monodisperse either from the point of view of chemical composition or degree of polymerization (*17, 19*). The degree of branching of these polymer chains would also be expected to influence their effectiveness as beater adhesives. Highly branched molecules would probably be less effective than similar linear molecules of the same D.P. The dilute solution viscosity behavior of the hemicelluloses suggests that they are essentially linear (*17, 19, 21*).

Preparation of Hemicelluloses

The representative hemicellulose fractions used in this study were obtained from aspen, black spruce, and Douglas-fir. They were isolated by aqueous potassium hydroxide extraction, under nitrogen, of holocelluloses prepared by a modified Thomas procedure as described elsewhere (*17, 19*). Briefly, the method consisted in treating the extractive-free moist wood meal with a solution of chlorine in carbon tetrachloride at 5°C., filtering, and then washing with a solution of ethanolamine in alcohol. Four or five such treatments were employed to yield the holocelluloses. Successive extractions of the air-dried holocellulose were then made under pure nitrogen with 5 and 16% aqueous potassium hydroxide, and the hemicelluloses were precipitated from these solutions by pouring into 4 volumes of ethanol containing sufficient acetic acid to neutralize the alkali. The two fractions thus obtained from each holocellulose are designated A and B, respectively. In the case of aspenwood two similar fractions were also obtained by direct aqueous potassium hydroxide extractions of the wood meal; these are referred to as fractions WA and WB, respectively. Aspen fraction FAA comprised the water-soluble portion (40%) of fraction A. Some physical constants for these hemicellulose fractions are summarized in Table I.

Table I. Collected Data for Hemicellulose Fractions[a]

Wood	*Fraction*	$[\eta]^{b,d}$	DP_n[c]	*Uronic*[d] *anhydride, %*	*Mannan, %*[d]
Aspen	A	0.60	140	14.8	Very small
	B	0.69	160	11.5	Very small
	WA	0.65	150	..	Very small
	WB	0.75	170	..	Very small
	FAA	0.57	130	20.0	Very small
Black spruce	A	0.64	140	21.1	7.7
	B	0.84	180	13.5	22.2
Douglas-fir	A	0.39	...	15.8	[e]
	B	0.46	...	13.8	[e]

[a] The data for the aspen and black spruce fractions have been reported previously (*17, 19*).
[b] Intrinsic viscosity measured in 10% aqueous potassium hydroxide.
[c] Number average degree of polymerization calculated as pentosan.
[d] Corrected for moisture and ash.
[e] Paper chromatography indicated that both hemicellulose fractions from Douglas-fir were relatively rich in mannan (ca. 20 to 30%), and that they both contained significant amounts of glucan and galactan (ca. 10%).

Preparation of Handsheets

The standard alpha pulp employed in this study had the following analysis: lignin 0.0%, pentosan 3.1%, alpha-cellulose 90.2%, and organic extractibles 0.3%. The pulp was beaten in a laboratory Valley beater with a bedplate loading of 5500 grams to a Schopper-Riegler freeness of 750 ml. at a pH of 7.0. Aqueous solutions of the hemicelluloses were added to the beaten pulp at a consistency of 1.5% and the slurry was stirred gently for $\frac{1}{2}$ hr. at a pH of 4.5. The percentages of hemicelluloses added ranged from 1 to 5% of the oven-dry weight of the pulp (retentions were not determined). The slurry was then diluted to a consistency of 0.5%, the pH readjusted to 4.5, and 45-lb. handsheets (25 × 40—500 basis) were prepared in a Valley mold. The sheets were pressed at a pressure of 50 p.s.i. for 5 min. and then heat dried on blotters at 105°C. for 3 min. The sheets were conditioned at 50% relative humidity and 73°F. prior to testing for bursting strength, Schopper tensile, and M.I.T. fold.

Influence of pH on the Sorption of Hemicelluloses

An initial series of orienting experiments was performed to determine whether pH during the period of stirring of the pulp slurry with the hemicellulose solution influenced the sorption of the hemicellulose onto the fibers. It was felt that the state of molecular aggregation of the hemicelluloses in solution might be influenced by pH to an extent sufficient to cause variation in the degree and manner of sorption. The hemicellulose fractions A of aspen and spruce were used for this study and the pH values used were 4.5 and 9.2. Bursting strength measurements on the handsheets prepared from slurries to which the weight of hemicellulose added was 3% indicated a small strength advantage for the lower pH. This lower pH was therefore used in all subsequent work. Of perhaps even greater interest than this influence of pH, however, was the fact that the spruce hemicelluloses produced greater improvements in bursting strength at both the lower and higher pH than did the aspen.

Influencing of Concentration, Structure, and Degree of Polymerization

Experiments were performed to provide a preliminary general picture of the influence of concentration, chemical structure, and degree of polymerization on the effectiveness of hemicelluloses as beater adhesives. Hemicellulose A from black spruce was used as the basis for comparison, and the data have been tabulated to facilitate discussion. It should be mentioned that

Table II. Influence of Hemicellulose Concentration—Spruce A

Hemicellulose added (based on pulp), %	*Basis weight (25 × 40—500), lb.*	*Bursting strength (Mullen), pt./100 lb.*	*Schopper tensile, lb./in.*	*M.I.T. fold*
0.0	44.9	55.2	15.7	36
1.0	43.4	58.5	15.2	32
3.0	45.0	68.2	17.3	78
5.0	45.4	79.3	19.8	130

the hemicellulose fractions A and B from black spruce and Douglas-fir were completely soluble in water at room temperature, whereas those from aspen were completely soluble only on warming. This warming was known to produce chain degradation (*17*); hence, the aqueous solutions of the fir and spruce hemicelluloses were prepared at room temperature and those of aspen with the minimum of heating. The concentrations of the solutions used in this preliminary study were not corrected for moisture and ash, which were present in amounts of about 10 and 5%, respectively.

The influence of hemicellulose concentration is shown by the data of Table II. Increasing the concentration of spruce A from 1 to 5% produced a progressive increase in the burst, tensile, and fold, indicating that sorption of the hemicelluloses increased with increasing concentration over this range. Retentions were not determined in this work but should certainly be measured in a more comprehensive study. The magnitude of the strength improvement observed is somewhat greater than would be expected for starch under comparable conditions (*22*) and somewhat less than for locust bean gum or guar (*23*).

A comparison of the adhesive properties of the two spruce fractions (A and B) is provided by the data of Table III. As was indicated in Table I, these two fractions differed not only in number average degree of polymerization but also in chemical composition. The striking superiority in strength improvement provided by fraction B may be attributed in part to its higher D.P.; this difference in D.P., however, is not large and it seems more probable that chemical differences are more important. The most striking chemical difference observed between these two fractions was the markedly higher percentage of the hexose mannan in fraction B, and it seems highly likely that this is the responsible factor; [cf. Jonas and Rieth (*2*)]. Further evidence supporting the view that the hexose mannose unit in hemicelluloses is important in relation to adhesive properties is contained in the data of Table IV. These data permit a comparison of the efficiency of the spruce fraction A which contained 7% mannan with the efficiencies of two aspen hemicellulose fractions which contained little or no mannan (as indicated by qualitative paper partition chromatography). The degrees of polymerization of the two aspen fractions were slightly above and slightly below that of the spruce, yet the spruce fraction provided significantly greater strength improvement. It should be noted, in this connection that, although the aspen fraction FAA was soluble in water at room temperature, the higher molecular weight fraction WB required warming to effect solution, and it appears possible that when this warm solution was added to the pulp slurry at room temperature some of the hemicelluloses may have separated out. The material which may have separated out would then probably have acted as a filler rather than as an adhesive [cf. March (*10*)].

Table III. Comparison of the Adhesive Properties of Black Spruce Fractions A and B

Hemicellulose added (based on pulp), %	*Basis weight (25 × 40—500), lb.*	*Bursting strength (Mullen), pt./100 lb.*	*Schopper tensile, lb./in.*	*M.I.T. fold*
0.0	44.9	55.2	15.7	36
3.0 Spruce A	45.0	68.2	17.3	78
3.0 Spruce B	45.1	82.7	19.7	138

Table IV. Comparison of the Adhesive Properties of Aspen Fractions FAA and WB with Black Spruce A

Hemicellulose added (based on pulp), %	*Basis weight (25 × 40—500), lb.*	*Bursting strength (Mullen), pt./100 lb.*	*Schopper tensile, lb./in.*	*M.I.T. fold*
0.0	44.9	55.2	15.7	36
5.0 Spruce A	45.4	79.3	19.8	130
5.0 Aspen FAA	45.6	68.8	17.9	65
5.0 Aspen WB	45.0	64.4	17.0	52

The influence of mild hydrolysis on the adhesive properties of spruce A is indicated by the data of Table V. The hemicellulose was hydrolyzed in aqueous solution by heating at 100°C. in the presence of air for times of 1 and 3 hr. The decreases in number average degree of polymerization as indicated by intrinsic viscosity measurements were about 3 and 10%, respectively. The results clearly indicate that these mild decreases in chain length did not interfere with the adhesive properties of the hemicellulose, and suggest that the molecular sizes present in the fraction were at least in large part significantly above the critical minimum discussed earlier as being required for adhesive film formation. In this connection it must be stressed that the degrees of polymerization of Table I are number average values and that it is highly probable that all the fractions used in this study were polydisperse; for example, Wethern (*19*) showed that the fraction here designated as spruce A contained molecules ranging in D.P. from 50 to over 300.

The results obtained with two hemicellulose fractions from Douglas-fir are compared in Table VI. The fractions had been characterized only to the extent of determining intrinsic viscosities in 10% aqueous potassium hydroxide—neither molecular weights nor chemical compositions had been determined. The low intrinsic viscosities—about half those for corresponding spruce fractions—suggested that perhaps the average degrees of polymerization of these fractions were low as compared with their spruce counterparts; and this, in turn, suggested that they might show up relatively poorly as beater adhesives. The experimental evidence, however, was to the contrary and showed that the fir hemicelluloses produced essentially the same strength improvement as did the spruce. A number of possible reasons can be advanced to explain these findings. On the basis of the limited evidence available, the most likely explanation seems to be that the degree of polymerization of the fir hemicelluloses was higher than the critical minimum postulated above, notwithstanding the relatively low intrinsic viscosities A more definite analysis must await additional experimental evidence.

Table V. Influence of Mild Degradation on Adhesive Properties of Spruce A

Hemicellulose added (based on pulp), %	*Conditions of degradation*	*Intrinsic viscosity [η]*	*Basis weight (25 × 40—500), lb.*	*Bursting strength (Mullen), pt./100 lb.*	*Schopper tensile, lb./in.*	*M.I.T. fold*
3	.....	0.64	45.0	68.2	17.3	78
3	1 hr. at 100°C.	0.62	44.6	71.1	17.3	90
3	3 hr. at 100°C.	0.57	44.8	70.5	17.5	95

Critical Minimum Degree of Polymerization

In order to establish that reduction in hemicellulose degree of polymerization below a certain minimum adversely influences adhesive properties, two of the softwood hemicellulose fractions were subjected to rather drastic hydrolytic degradation and then tested as beater adhesives. One per cent aqueous solutions of fraction A from Douglas-fir and fraction B from black spruce were hydrolyzed as follows: the pH of each was adjusted to 4.0 with acetic acid and the solutions were heated at 100°C. for 20 hr. after which portions of the solutions were removed for testing; the pH of the remaining portions was adjusted to 2.7 with hydrochloric acid, and the hydrolysis at 100°C. was continued for an additional 20 hr. The data of Table VII provide a comparison of the adhesive properties of the original and degraded hemicellulose fractions when added in the amount of 3% based on the pulp; in the case of the spruce experiments, the number average degrees of polymerization were estimated from the viscosity data.

Table VI. Comparison of the Adhesive Properties of Douglas-Fir Fractions A and B

Hemicellulose added (based on pulp), %	*Basis weight (25 × 40—500), lb.*	*Bursting strength (Mullen), pt./100 lb.*	*Schopper tensile, lb./in.*	*M.I.T. fold*
0.0	44.9	55.2	15.7	36
3 Douglas-fir A	44.4	66.7	16.6	57
3 Douglas-fir B	43.7	80.1	18.0	172

Serious impairment in strength properties is seen to have accompanied this rather harsh hydrolytic degradation of the hemicelluloses; it is also seen that the degree of this strength impairment increased as the extent of degradation increased. A direct correlation between degree of polymerization and adhesive strength is not possible from these data because the hemicellulose fractions were polydisperse (the degrees of polymerization shown in the table are number average values). Such a direct correlation would require the use of carefully fractionated samples which were molecularly and chemically uniform. The evidence clearly indicates, nevertheless, that seriously degraded hemicelluloses are much less effective as beater adhesives than are the corresponding representative undegraded fractions and it also supports the postulate that a critical minimum degree of polymerization exists.

PART II. HEMICELLULOSE COMPOSITION AND ADHESIVE STRENGTH

The preliminary experiments described in Part I indicated that the hemicelluloses of the softwoods, black spruce and Douglas-fir, are much more effective as beater adhesives than are those of the hardwood aspen. This superiority of the softwood hemicelluloses was tentatively attributed to their higher hexosan content (chiefly mannan). Further evidence supporting this view was provided by the observation that in the case of the two fractions from spruce—one of which had a mannan content of 7% and the other a mannan content of 22%—that fraction with the higher mannan content was significantly more effective as a beater adhesive. It was felt that a more detailed study should be made of this apparent correlation between mannan content and strength contribution. To this end, therefore, four hemicellulose fractions of different mannan contents were isolated from a slash pine holocellulose, and these were then compared as beater adhesives.

Preparation and Analysis of the Hemicellulose Fractions

The hemicellulose fractions were isolated by successive extraction of a slash pine chlorite holocellulose with 1, 4, 7, and 16% potassium hydroxide. The extractions were carried out *without* the use of nitrogen, and the hemicelluloses were recovered in each case by acidification of the filtered alkaline solution with acetic acid followed by precipitation with alcohol. No attempt was made to insure quantitative recoveries. Some properties of the fractions are shown in Table VIII. The mannan contents were determined by hydrolyzing the fractions and weighing the mannose as the insoluble phenylhydrazone (*24*). It will be noted that the results show a steadily increasing mannan content from fraction I through fraction IV—ranging from 5.4 to 22.6%. Pentosans were determined by the usual gravimetric furfural phloroglucide procedure (*25*).

Table VII. Influence of Severe Hydrolytic Degradation on the Adhesive Properties of Douglas-Fir A and Black Spruce B Hemicellulose Fractions

Hemicellulose added (based on pulp), %	*Degradation[a] stage*	$\eta_{sp}{}^{b}/C$	*DPn[c]*	*Basis weight (25 × 40—500), lb.*	*Bursting strength (Mullen), pt./100 lb.*	*Schopper tensile, lb./in.*	*M.I.T. fold*
0.0	...	...	...	41.2	44	11.7	11
3 Douglas-fir A	None	0.33	...	41.9	69	16.7	50
	First	0.12	...	40.6	60	14.6	27
	Second	0.05	...	41.7	47	13.0	16
3 Black spruce B	None	0.94	180	41.1	76	17.9	122
	First	0.37	70	40.8	62	15.4	39
	Second	0.10	20	42.2	54	13.7	19

[a] First stage—20 hr. at 100°C., pH 4.2; second stage—20 hr. at 100°C., pH 2.7.
[b] Reduced specific viscosity in 10% aqueous KOH; C = 0.55 g./100 ml.
[c] Approximate number average degree of polymerization (as pentosan).

Table VIII. Some Properties of the Hemicellulose Fractions from Slash Pine

Fraction	Extract, % KOH	Yield,[a, b] %	Mannan,[b] %	Pentosan,[b] %	$[\eta]^b$ in 10% KOH	DP_n[c]
I	1	42	5.4	49.5	0.44	100
II	4	17	10.2	56.1	0.47	105
III	7	19	15.2	48.9	0.55	120
IV	16	22	22.6	27.8	0.59	130

[a] Based on total hemicellulose; yield of hemicellulose based on holocellulose was 18%.
[b] Corrected for moisture and ash.
[c] Estimated from viscosity data.

The hemicellulose samples were too small to permit determinations of the uronic anhydride groups present; the pentosans, therefore, remain uncorrected for this component. It would be expected, however, that the uronic anhydride content would be highest in fraction I and would diminish progressively through fractions II, III, and IV. Paper chromatography of portions of the neutral hydrolyzates from the mannan determinations showed the presence of xylose, arabinose, galactose, glucose, and mannose. Quantitative determinations of the ratios of these sugars on the paper strips by the method of Hirst and Jones (*26*) were also made. Because of the drastic conditions of the hydrolysis, serious losses of the various sugars—especially xylose—almost certainly occurred, and a precise evaluation of the ratios of the various sugars was not possible. However, a definite trend could be noted from fraction I through fraction IV: the mannan and glucan contents increased steadily with a concomitant drop in xylan, araban, and galactan; the *over-all hexosan* content increased with increasing strength of alkali used in the hemicellulose extraction; the *over-all pentosan* content decreased.

The intrinsic viscosities, $[\eta]$, shown in column 6 of Table VIII were obtained in the usual manner with Ostwald-Fenske viscometers at 30°C. It will be noted that these viscosities increase from fraction I through fraction IV as would be expected. The corresponding values for the number-average degree of polymerization, DP_n, are shown in column 7 and range from about 100 for fraction I to about 130 for fraction IV. These values were obtained by using the "viscosity-degree of polymerization" relationship shown to hold for black spruce hemicelluloses (*19*), and the results must therefore be regarded as approximate only. The spread in DP_n for the four fractions is relatively narrow and, on the basis of results obtained with the mildly degraded spruce A fractions (Table V), it may reasonably be assumed that differences in effectiveness of these fractions as beater adhesives would be more dependent on differences in chemical composition than on differences in DP_n.

Preparation of Handsheets

The adhesive properties of the four slash pine hemicellulose fractions were determined by making strength measurements on handsheets prepared as described in Part I. The measurements were made as before at 50% relative humidity and 73°F. and include bursting strength (Mullen), Schopper tensile, M.I.T. fold, and Elmendorf tear.

Comparison of the Adhesive Properties of the Hemicellulose Fractions

A comparison of the adhesive properties of the four slash pine hemicellulose fractions is provided by the data of Table IX. Handsheet data corresponding to the addition of 1 and 5% of each of the four fractions (based on the moisture-free weight of the pulp) show a steady increase in bursting strength from fraction I through fraction IV. It should be noted that the percentages of the hemicelluloses added were not corrected for the presence of ash, and that this value in general was about 10% or less. However, in the case of fraction IV, it was found that the ash content was much higher, viz., 34% (the greater portion of which was shown to be occluded potassium acetate). The hand-

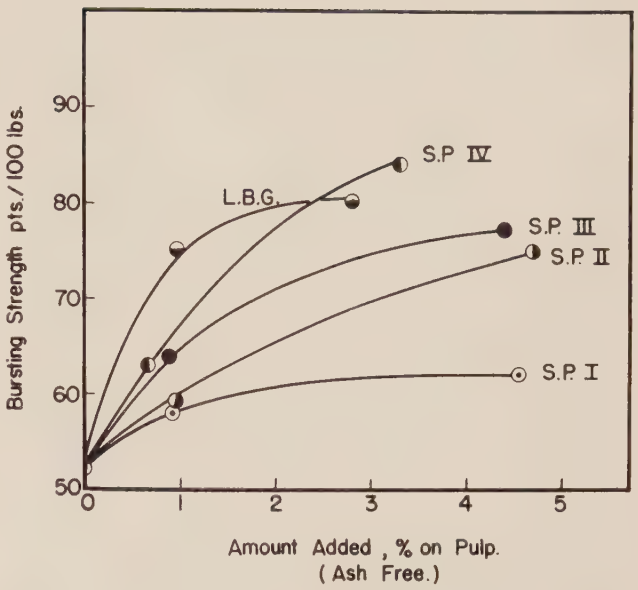

Fig. 2. Plot of bursting strength against amount of polysaccharide added for locust bean gum and four hemicellulose fractions from slash pine

Table IX. Comparison of the Adhesive Properties of Hemicellulose Fractions and Locust Bean Gum

Hemicellulose added (based on pulp), %	Basis weight (25 × 40—500), lb.	Bursting strength (Mullen), pt./100 lb.	Schopper tensile, lb./in.	M.I.T. fold	Tear factor
0.0	42.5	52	13.6	22	1.22
Slash pine I					
1	44.3	58	15.0	33	1.20
5	42.4	62	15.6	46	1.08
Slash pine II					
1	42.0	59	14.6	32	1.07
5	40.0	75	16.9	90	1.05
Slash pine III					
1	42.5	64	16.2	42	1.15
5	43.3	77	19.3	124	1.02
Slash pine IV					
1	41.2	63	15.2	41	1.14
5	42.9	84	18.9	212	1.00
Locust bean gum					
1	44.0	75	18.4	92	1.02
3	44.5	80	19.8	143	1.08
Spruce A					
1	40.5	61	18.4	37	1.16
5	43.2	72	17.8	92	1.06
Black spruce B					
1	41.6	67	14.9	50	1.15
5	43.2	85	19.5	135	1.09
Douglas-fir B					
1	42.5	68	15.8	45	1.15
5	45.5	82	19.9	132	1.08
0.0	43.4	54	14.2	20	1.27

sheet data associated with fraction IV must therefore be interpreted in the light of this knowledge.

The complex nature of the ash in the several hemicellulose fractions renders impossible an accurate correction for this impurity at this time.* However, it is desirable to compare these materials insofar as possible on the basis of the true polysaccharide content of each sample. An attempt has been made to do this in the case of the data plotted in Fig. 2, where bursting strength is shown as a function of the amount of polysaccharide added for the four hemicellulose fractions from slash pine and for locust bean gum. The weights of the hemicellulose fractions were corrected for moisture, and a correction for ash was estimated from ash data. The bursting strength data are admittedly meager for meaningful plotting, but in view of the preliminary and orienting nature of the present work, it is felt that the curves do serve to indicate trends which are worthy of note. The locust bean gum curve—included for comparison and corrected for 6% inert protein—may be regarded as being more firmly established than the others because this polysaccharide has been rather extensively studied as a beater adhesive (*23*). The corrected curves emphasize the differences between the efficiencies of the four slash pine hemicellulose fractions as beater adhesives and show clearly that this efficiency increases markedly from fraction I through fraction IV. At low concentrations of polysaccharide added, the locust bean gum was more effective than the hemicellulose fractions; at the higher concentrations the curves for fractions II and III appear to level off at a value close to that attained by the locust bean gum. The curve for fraction IV suggests a possible higher value for the maximum efficiency in this latter case. It is interesting to note that similar plots of the data for the hemicellulose B fractions of black spruce and Douglas-fir would yield curves almost identical with that obtained for fraction IV of slash pine. The observation that at the lower concentrations the hemicellulose fractions are less effective than the locust bean gum indicates either that the hemicelluloses are not retained by the cellulose fibers to the same extent as is the locust bean gum, or that the portions retained are not as effective adhesives on a weight basis. This aspect of the work merits more detailed study. The tensile strength and folding endurance data show variations which parallel those shown by the bursting strength data. This supports the considerations outlined above.

* The correction for "ash" in a sample of hemicelluloses has been problematical. Ash figures are always significant, and often they are very high. In the past, arbitrary corrections have been made as follows: The dried sample was charred, treated repeatedly with concentrated sulphuric acid, and the total mineral matter determined as "sulphated ash." This ash has been leached repeatedly with hot water, and the *water-insoluble ash* (A) determined. It has been assumed that the soluble (major) portion of the ash was potassium sulphate (B) and it was also assumed that this emanated from potassium salts of the uronic acid units in the hemicelluloses. That this was normally justifiable had been indicated by a few preliminary experiments made several years ago. Hence, the *potassium* content (C) of the weighed *potassium sulphate*, was calculated. The ash correction thus became the sum of (A) and (C). However, in the present study the ash content of several hemicellulose preparations was unusually high and, in one case, the sulphated ash exceeded 35%. Hence, the total ash could not be ascribed merely to insoluble (siliceous matter) or to potassium uronide. It was found that despite its great solubility in ethanol, potassium acetate is occluded and tenaciously held by hemicelluloses, especially when the extraction is made with high concentrations of potassium hydroxide. Hence, a revised "ash correction" had to be made. A weighed sample of each hemicellulose (used in the subsequent beater runs) was extracted exhaustively with *hot* alcohol. These alcoholic solutions were then evaporated and dried to constant weight. This weight (D) (due to occluded potassium acetate) was recalculated to *potassium sulphate*, and the weight of this sulphate (E) subtracted from that of the total soluble sulphated ash (B). This difference was then calculated as "potassium" (F) (which presumably is due to the original potassium uronide). The correction applied for foreign matter in the hemicelluloses thus becomes the sum of A (insolubles) + F (potassium due to uronides) + D (potassium acetate). All ash corrections were made on this basis.

The tearing strength, which is expressed as the tear factor in Table IX, shows a decrease with increasing amount of beater adhesive added. This is consistent with the nature of the tear test which normally indicates a decrease in the tear factor as the fiber-to-fiber bonding becomes greater.

Included in Table IX are data for two representative hemicellulose fractions from black spruce (a 5 and a 16% KOH extract from a modified Thomas holocellulose) and one from Douglas-fir (a 16% KOH fraction from a modified Thomas holocellulose). These data were obtained in order that a comparison might be made between the efficiencies of the hemicelluloses as beater adhesives and that of locust bean gum, and also to permit a comparison with the earlier data for the spruce and Douglas-fir hemicelluloses.

The evidence thus obtained is in accord with that described in Part I, and offers strong support for the view that the effectiveness of hemicelluloses increases as the mannan (hexosan) content increases—other factors being equal. Strictly speaking, of course, our present knowledge of the hemicelluloses does not permit us to say with any degree of certainty that "other factors" actually were equal. In fact, that the fractions employed differed in a number of ways including average degree of polymerization, degree of branching, uronic anhydride content, etc., is almost certain. These latter differences, however, would appear to be small on the basis of our present knowledge. The paramount differences between the fractions seem to lie in their mannan (hexosan) contents; hence the efficiency of each fraction as a beater adhesive appears to be simply related to this mannan (hexosan) content.

PART III. ARABOGALACTANS AS BEATER ADHESIVES

The arabogalactans differ from the hemicelluloses in that they do not form part of the cell wall of the parent tree. They may be extracted readily and completely with cold water. In general, the yields are low except in the case of larch where it may be as high as 20%. Some properties of the arabogalactans of larch, black spruce, and Douglas-fir have recently been described (*27*). Their relatively high number average degree of polymerization (about 400) and their low intrinsic viscosities in 10% KOH (about 0.07) indicate that they are much more highly branched than are the hemicelluloses. They are, however, all relatively rich in the hexosan galactan (their hydrolyzates contain from 71 to 90% of galactose). It was considered of interest to examine the effectiveness of these polysaccharides as beater adhesives and thus provide some evidence concerning the influence of branching. The ease with which these polysaccharides can be extracted from the respective parent woods suggests that retentions in or by pulps under ordinary conditions would be negligible and this, of course, would render them ineffective as beater adhesives.

The arabogalactans were added as aqueous solutions to the standard alpha pulp in amounts corresponding to 3 and 5% of the moisture-free weight of the pulp and under conditions identical with those described above for the addition of the hemicelluloses. Handsheets were prepared and tested in the standard manner, and the data are presented in Table X. Included in this table are

data for the 5% KOH extract from black spruce; these latter experiments were termed "hemicellulose controls" and were intended to permit a comparison with data from the earlier work. It will be clear from the data presented that the three arabogalactans were completely ineffective as beater adhesives under the experimental conditions employed. It seems reasonable to believe that the highly branched character of these polysaccharides is responsible for the phenomenon

Table X. Adhesive Properties of Arabogalactans

Arabogalactan added (based on pulp), (%)	*Basis weight (25 × 40—500), lb.*	*Bursting strength (Mullen), pt./100 lb.*	*Schopper tensile, lb./in.*	*M.I.T. fold*	*Tear factor*
None	43.2	54	13.4	24	1.27
Western larch					
3	42.1	52	12.9	26	1.26
5	42.9	55	13.6	27	1.19
10	42.2	55	13.4	25	1.21
Douglas-fir					
3	42.2	56	14.3	29	1.18
5	44.0	56	14.7	28	1.20
Black spruce					
3	42.2	56	14.2	30	1.16
5	43.3	56	14.6	26	1.27
Hemicellulose control, black spruce A					
3	42.7	70	17.0	90	1.10
5	43.6	72	16.8	79	1.08

observed. Here again, however, our knowledge of the properties and behavior of the various polysaccharide systems is at present too meager to permit definite conclusions. There is no experimental evidence, for instance, to indicate whether a linear polymer molecule consisting entirely of galactose units is more or less effective than a similar linear polymer molecule consisting entirely of mannose units. Extension of our knowledge along these lines to include the influence on adhesive properties of degree of polymerization, degree of branching, and nature of constituent sugars, would appear to be highly desirable.

LITERATURE CITED

1. Young, G. H., and Rowland, B. N., *Paper Trade J.* 97, No. 15: 44 (Oct. 12, 1933).
2. Jonas, K. G., and Rieth, E., *Wochbl. Papierfabr.* 64, No. 48: 853–855 (Dec. 21, 1933).
3. Obermanns, H. E., *Paper Trade J.* 103, No. 7: 83–91 (Aug. 13, 1936).
4. Houtz, H. H., and Kurth, E. F., *Paper Trade J.* 109, No. 24: 38–41 (Dec. 14, 1939).
5. Jayme, G., *Papier-Fabr.* 1942, No. 35/36: 137–144; No. 37/38: 145–152.
6. Jayme, G., and Lochmüller-Kerler, E., *Wochbl. Papierfabr.* 1944, No. 7: 223.
7. Jayme, G., and Rothamel, L., *Das Papier* 2: 7 (Jan., 1948).
8. Jayme, G., and Lochmüller-Kerler, E., *Holz als Roh- u. Werkstoff* 5, No. 11: 377–381 (Nov., 1942).
9. Jayme, G., Wagenblach, H., and Deloff, W., *Papier-Fabr.* 37: 353–357 (1939) 361–367.
10. March, R. E., *Paper Trade J.* 127, No. 17: 51 (Oct. 21, 1948).
11. Ratliff, F. T., *Tappi* 32, No. 8: 359 (Aug., 1949).
12. Fineman, M. N., *Tappi* 35, No. 7: 320 (July, 1952).

12a. Khinchin, Y. G., *Bumazhnaya Prom.* 18, No. 12: 7 (1940); cf *C.A.* 34: 4902[8].

13. Ross, J. H., *Pulp Paper Mag. Canada* 51, No. 1: 93 (Jan., 1950).
14. Cottrall, L. G., *Tappi* 33, No. 9: 471 (Sept., 1950).
15. Forman, L. V., *Tappi* 33, No. 9: 444–450 (Sept., 1950).
16. Wise, L. E., in Wise and Jahn, "Wood Chemistry," 2nd ed., vol. I, page 369, New York, Reinhold Publishing Corp., 1952.
17. Thompson, J. O., and Wise, L. E., *Tappi* 35, No. 7: 331 (July, 1952).
18. Timell, T. E., and Jahn, E. C., *Svensk Papperstidn.* 54: 831 (1951).
19. Wethern, J. D., *Tappi* 35, No. 6: 267–271 (June, 1952).
20. Mark, H., *Ind. Eng. Chem.*, 34: 1343 (1942).
21. Husemann, E., *J. prakt. Chem.* 155: 13–64 (1940).
22. Swanson, J. W., Unpublished data.
23. Swanson, J. W., *Tappi* 33, No. 9: 451 (1950).
24. Wise, L. E., Ratliff, E. K., and Browning, B. L., *Anal. Chem.* 20: 825 (1948).
25. Kröber, E., *J. Landwirtsch.* 48: 357 (1900), 49: 7 (1901).
26. Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.* 1949: 1659.
27. Thompson, J. O., Becher, J. J., and Wise, L. E., *Tappi* 36, No. 7: 319–324 (July 1953).

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A Physicochemical Study of a Water-Soluble Polysaccharide from Black Spruce (*Picea mariana*)

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A brief study has been made of some molecular properties of a cold water-soluble polysaccharide system from black sprucewood isolated under mild conditions and in a yield of 1.6%. Paper chromatography of the hydrolyzate showed the presence of galactose, arabinose, and small amounts of acidic material. The aqueous solution had a pH of 7.5, $[\alpha]_D$ − 11°, and an intrinsic viscosity of 0.16. Osmotic pressure measurements on an acetate (degree of substitution about 2) in acetone indicated a DP_n of about 330. Similar measurements in chloroform indicated molecular association in that solvent. Hot-water treatment of the fibrous residue which remained after the cold-water extraction was shown to remove appreciable amounts of carbohydrate material, including units of glucose, mannose, and xylose, in addition to galactose and arabinose. The pH of the extract was 4.5; it was considered probable that acid hydrolysis of cell wall material had occurred.

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The present paper describes the results of a brief physicochemical study of a cold-water soluble polysaccharide system from black spruce (*Picea mariana*). Brauns (*1*) has described the isolation, from this wood, of a mixture of native lignin and polysaccharide with aqueous alcohol. He separated the polysaccharide from the mixture in a yield of about 0.1 to 0.2% of the wood, and obtained analytical data which indicated that three components—galactose, arabinose, and uronic acid—were present in a 4:1:1 molecular ratio. Clermont and Schwartz (*2*) have reported a value of 1.41% for the cold-water solubility of

Table I. Comparative Data for Arabogalactans

	Yield, %	$[\alpha]_D^{25}$	Constituent sugars, weight %[a] Galactose	Arabinose	Xylose	Uronic acid	Intrinsic viscosity Water	10% KOH	DP_n
Western larch	18.0	+11°	88	12	..	Trace	0.06	0.07	300[b]
Douglas-fir	0.8	+19°	90	9	1	Trace	0.27	0.07	425
Black spruce	1.6	−11°	71	18	.. ..	11	0.16	0.08	330

[a] Based on oven-dry and ash-free polysaccharide. [b] Mosimann and Svedberg (*4*) (European larch).

black spruce. In the present work, it was considered of particular interest to isolate the polysaccharide directly with water and in a mild manner, and then to determine the number-average degree of polymerization, DP_n, and the dilute solution viscosity behavior of the system. This would provide a basis for comparison with the data of Husemann (*3*) and of Mosimann and Svedberg (*4*) for the arabogalactan of larch, and with the data of Thompson, Becher, and Wise (*5*) for the corresponding polysaccharide system of Douglas-fir.

PREPARATION AND PROPERTIES OF THE POLYSACCHARIDE

Black spruce sawdust, 30 to 80 mesh, was prepared in the usual manner from a freshly cut and peeled log. The meal was extracted with oxygen-free distilled water under an atmosphere of nitrogen for 1 hr. at room temperature (2 ml. of water per gram of oven-dry wood). The aqueous extract was separated by filtration and then poured into 4 volumes of ethanol, whereupon the polysaccharide separated as a white flocculent precipitate. This was separated by centrifuging. The polysaccharide was then redissolved in oxygen-free water, filtered through paper, reprecipitated with 4 volumes of ethanol, and again separated by centrifuging. After washing several times with ethanol and with absolute ether, and then drying under reduced pressure at room temperature, the product was recovered as a white fluffy powder in a yield of 1.6% (based on the moisture-free weight of the wood). Reextraction of the wood meal with cold water yielded no further polysaccharide. Concentration of the aqueous extract before the precipitation with alcohol was avoided in the present work in order that opportunity for degradation of the polymer molecules would be minimized.

The polysaccharide dissolved readily in cold water and in formamide without swelling to give clear solutions. A 2% solution in water had a pH of 7.5 and $[\alpha]_D^{25} - 11°$. The sulphated ash was 3.4%, the pentosan content (from furfural determination) 16.0%, and the uronic anhydride content (from CO_2 determination) 10.3%. Paper chromatography of the hydrolyzate from sulphurous acid hydrolysis at 135° for 90 min. indicated a preponderance of galactose, a lesser amount of arabinose, and a small amount of acidic material. Quantitative analysis of the hydrolyzate by the paper chromatographic method of Hirst and Jones (*6*) indicated a ratio of galactose to arabinose of 4:1 by weight (based on ash-free and uronic acid-free material). These data indicate an over-all composition for the polysaccharide system of 71% galactose, 18% arabinose, and 11% uronic acid by weight (based on ash-free material), which corresponds to a molecular ratio of about 6:2:1.

The acetate was prepared with pyridine and acetic anhydride at room temperature as described elsewhere (*5*) for the preparation of the acetate of the water-soluble polysaccharide from Douglas-fir. The product had an acetyl content of 36% (degree of substitution of about 2) as determined by the method of Genung and Mallat (*7*). It was completely soluble in chloroform and about 70% soluble in acetone. The chloroform solution had a negative rotation.

Dilute solution viscosity measurements were made on the polysaccharide and on its acetate with Ostwald-Fenske viscometers which had flow times for water of about 200 sec. at 30°C. Intrinsic viscosities of the polysaccharide in water and in 10% potassium hydroxide solution were 0.16 and 0.09, respectively; that for the acetate in chloroform was 0.18. The concentration units used in obtaining these intrinsic viscosities were grams per 100 ml.

Osmotic pressure measurements were made on chloroform and acetone solutions of the acetate with osmometers of the Zimm and Myerson design (*8*). The apparent number-average molecular weights, M_n, in the two solvents were 128,000 and 80,000, respectively. It is probable that the higher molecular weight in chloroform resulted from molecular association in that solvent (*5*, *9*). If the assumption is made that the acetate is not significantly associated in dilute acetone solutions, the osmotic data indicate a value of 51,000 for the number-average molecular weight of the original polysaccharide. This corresponds to a number-average degree of polymerization, DP_n, of about 330.

Some molecular properties of the cold water-soluble polysaccharide systems of western larch, Douglas-fir, and black spruce are compared in Table I. The yield data are in agreement with those previously reported by others and show the relatively high percentage of arabogalactans found in western larch. The specific rotations in aqueous solution are positive and of about the same magnitude for the western larch and Douglas-fir systems, whereas that for black spruce is negative. The chief difference between the compositions of the hydrolyzates of the three systems is the presence of 11% uronic acid in the black spruce system. The presence of the small percentage of xylose and the trace of mannose in the Douglas-fir system is interesting but would hardly be expected to influence the properties of the system to any significant degree.

The intrinsic viscosities of the three systems in 10% potassium hydroxide solution are all very low and of essentially the same magnitude. In water solution those of Douglas-fir and black spruce are both significantly greater than that of western larch. The exact significance of these results is not clear but one explanation (*5*) lies in the possibility that the polysaccharide of western larch is more highly branched (lower viscosity) than that of Douglas-fir or black spruce. This is based on the observation that the osmotic pressure measurements indicate number-average degrees of polymerization of essentially the same order of magnitude for the three systems. However, the osmotic pressure measurements provide no informa-

tion concerning molecular size distribution and, therefore, are of limited significance. Sedimentation equilibrium and fractionation studies on these systems should prove very interesting in this connection. Another avenue of study which merits further work is the preparation, without molecular degradation, of derivatives soluble in organic solvents. Such derivatives are essential in order to avoid the complications which often result when molecular properties are studied in aqueous solutions (*10*). For most systems the acetate is prepared quite readily but it seems to suffer from the serious disadvantage that in some solvents at least molecular association occurs.

It is interesting to note that the intrinsic viscosities of the arabogalactans in 10% potassium hydroxide solution are about one tenth the magnitude of those for representative hemicellulose fractions in the same solvent (*3*, *10*, *11*) notwithstanding the fact that osmotic pressure data show that the values of DP_n for the arabogalactans are two to three times that for the hemicelluloses. This suggests that the arabogalactans are very highly branched, which is in accord with the observation that they dissolve readily in water and without swelling.

Infrared spectra for the three polysaccharide systems are shown in Fig. 1. These were obtained with a Model 12-B Perkin-Elmer spectrometer equipped with a General Motors breaker-type amplifier and a Brown strip recorder. A sodium chloride prism was used and mulls were prepared in Nujol and hexachlorobutadiene. No significant differences between the three spectra are apparent.

It was considered of interest to determine whether hot-water extraction of the wood meal which remained after the cold-water treatment would remove sugar constituents other than those extraneous to the cell wall as had been previously observed in the case of Douglas-fir wood (*5*). Accordingly, the cold-water extracted wood meal was heated with water on the steam bath for 6 hr. The pH of the extract was 4.5 (in contrast to pH 7.4 of the cold-water extract). This hot-water extract was hydrolyzed and the constituent sugars separated by means of paper chromatography. It was found that, in addition to galactose and arabinose, the sugars glucose, mannose, and xylose were present in appreciable amounts. A photograph of the chromatograms obtained in this study is shown in Fig. 2. Column I shows the spots obtained with a reference mixture of galactose, glucose, mannose, arabinose, and xylose. Column II shows the spots for galactose and arabinose obtained with the hydrolyzate of the cold-water extract. This column is identical with one obtained with a hydrolyzate from western larch arabogalactan. Both of

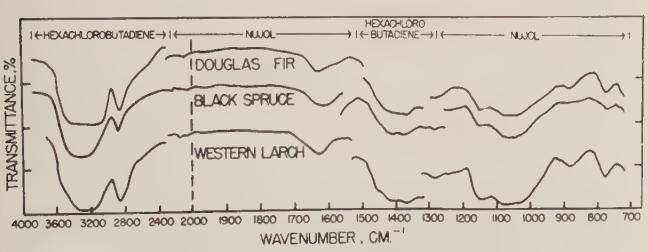

Fig. 1. Infrared spectra of the arabogalactans of Douglas-fir, black spruce, and western larch

(50% transmittance values are indicated for each spectrum)

Fig. 2. Paper chromatograms; I, reference mixture of known sugars; II, hydrolyzate of cold-water extract; III, hydrolyzate of hot-water extract; IV, hydrolyzate of representative hemicellulose fraction.

these differed from the corresponding chromatogram for the Douglas-fir polysaccharide system in that no traces of xylose and mannose were detected. The spots obtained with the hydrolyzate of the hot-water extract are shown in column III. It will be noted that in this column the galactose and arabinose spots are somewhat darker than those for the other sugars. This suggests the presence of arabogalactan in the hot-water extract which probably resulted from incomplete removal from the wood during the cold-water extraction. Column IV shows the chromatogram obtained with the hydrolyzate of a representative hemicellulose fraction prepared from a portion of the same sample of wood.

The action of the hot water on the black sprucewood thus appears to be essentially the same as that previously reported for Douglas-fir wood (*5*). In both cases the evidence suggests that acid hydrolysis of the cell wall components occurs during hot-water extraction.

LITERATURE CITED

1. Brauns, F. E., *Science* 102: 155 (1945).
2. Clermont, L. P., and Schwartz, H., *Pulp Paper Mag. Canada* 52, No. 13: 102 (1951).
3. Husemann, E., *J. prakt. Chem.* 155: 13–64 (1940).
4. Mosimann, H., and Svedberg, T., *Kolloid-Z.* 100: 99–105 (1942).
5. Thompson, J. O., Becher, J. J., and Wise, L. E., *Tappi* 36, No 7: 319–324 (1953).
6. Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.* 1949: 1659.
7. Genung, L. B., and Mallatt, R. C., *Ind. Eng. Chem., Anal. Ed.* 13: 369–374 (1941).
8. Zimm, B. H., and Myerson, I., *J. Am. Chem. Soc.* 68: 911–913 (1946).
9. Doty, P., Wagner, H., and Singer, S., *J. Phys. Colloid Chem.* 51: 32–57 (1947).
10. Thompson, J. O., and Wise, L. E., *Tappi* 35: 331–336 (1952).
11. Wethern, J. D., *Tappi* 35: 267–271 (1952).

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The Fundamentals of Control Charts

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There are some limitations to the direct application of control charts to production control in the pulp and paper industry. However, in the past few years, more than 50 articles on statistics have appeared in journals serving the trade. Many of these have involved variations in conventional control charts. This is evidence of the substantial utility to the industry of the control chart as a method of analyzing data and as a means of process control after the proper control points have been identified by analytical means. One of the major problems to be overcome in any particular application is the rational subgrouping of data to arrive at appropriate limits for the chart. The choice of grouping depends on more information about the sources of variation in paper quality than is usually on hand. This lack is being overcome as more is learned about the variability of paper testing and sampling techniques. New types of measurement devices such as beta gages are helping to accumulate the basic variation information needed for intelligent chart control. Inherent in the success of any plan of control is a method for obtaining positive action to correct causes of lack of control as they occur. This means that the limits must be established on "economic" bases as well as that supervision must be ready to make changes upon the advice of the quality control engineer. Finally, if the charts are intended as a means of currently controlling the output of a paper machine, they must be simple enough for any operator to use and understand. The advantages of the quality control program must be kept before the whole organization as constantly as any other important program, such as safety.

BEFORE any kind of analysis of data makes sense, there must be a need for and an appreciation of the kind of information that the analysis can produce. Thus, before control charts can be successful in a pulp or paper mill there must be a problem that they are capable of solving. Also, there must be sufficient understanding of the use of the charts to lead to positive action to correct causes of lack of control as they occur.

There are some limitations to the direct application of the control charts to production control in the pulp and paper industry. Nevertheless, many of the more than 50 articles on statistical applications in the industry that have appeared in recent years have described uses of control charts (see references *1* to *12*). These give evidence of substantial utility to the industry of the control chart as a method of analyzing data. Many examples have been given of successful uses of control charts as means of process control, particularly after the proper control points have been identified by other methods of analysis.*

Appreciation of the utility of statistical information amounts to recognition that there is variation in all measurements; that it is important to do something about this variation; and that something usually can be done about it when the sources of significant variations are identified. Some analysis of the relative contribution of different sources of variation to the total variability of product quality is essential to the intelligent application of corrective action. Every process has latent capabilities which should be exploited fully before costly process changes are considered. These capabilities may be established by careful sampling and testing. It may be too difficult or costly to do anything about some of the sources of variation. These are among the things that should be determined with certainty. On the other hand, improvements often occur immediately upon starting control chart analysis. This may be due to a psychological effect that comes about because attention has been given to seeking the causes of variation.

Variations in measurement pervade all parts of the industry from the raw materials for pulp preparation all the way through the sheeting operation to the end use of the finished product. These variations arise from the materials themselves, from the instruments of measurement, from the processing equipment, and from the human beings who handle the whole manufacturing sequence. The comments made on the use of control charts apply equally well to most of the different tests used to measure all kinds of properties of pulp and paper.

EARLY USE OF CONTROL CHARTS

The pulp and paper industry began to take an interest in statistical quality control quite early in the surge of activity that accompanied formation of the American Society for Quality Control (ASQC). In 1944, Catlin (*1*) wrote an article that aroused attention even outside the industry. By 1946 the Statistics Committee of the Technical Association of the Pulp and Paper Industry was presenting programs at the annual convention of the association and encouraging similar talks at section meetings. During the same year, applications of industrial statistics to papermaking were described by Knoll† at the short course in quality control for the chemical industries at the Rochester Institute of Technology.

A great deal of the work that has been done since has involved variations in the application of conventional control charts. As Noble (*2*) has pointed out, these variations are necessitated by the normal shifts in process averages and the stratifications inherent in certain papermaking operations. It is only by reading many of the articles which describe control chart applications that a well-rounded impression can be obtained of the impact of statistics on paper machine control.

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* As examples of other useful methods of analysis, correlation techniques may be used to measure significant interrelationships in existing data, or analysis of variance may be applied to data acquired especially for the purpose in a statistically designed experiment.

† Ralph J. Knoll, Scott Paper Co., Chester, Pa.

It is to the credit of both ASQC and TAPPI that their policies have been that the greater the diversification of workable methods presented, the greater the chance for stimulating the development of new and still better methods. In spite of all the work that has been done, the question of what is the best method of handling paper machine data might well remain open for some time, until a lot more paper machine data have been analyzed by modern statistical methods.

The author (in references *3* through *6*) has expanded on the simple process control concepts introduced by Catlin, principally by describing case studies of successful applications. Several different approaches to paper machine control have been described but no one approach has been advocated as the best to the exclusion of all others. It was believed that, instead, emphasis should be placed on the importance of investigative work in: (1) understanding the papermaking process, (2) learning the factors affecting uniformity and quality level of papermaking materials, (3) learning enough about cause and effect to permit use of control charts efficiently.

Many writers and many mills have contributed to the advancement of paper machine control. However, progress has been made very slowly throughout the industry as a whole. It is significant that the first course in quality control exclusively for the pulp and paper industry was not held until the Summer of 1952.

THE IMPORTANCE OF ENGINEERING JUDGMENT

The widespread participation in the 1952 course sponsored by TAPPI indicates that quality control is coming of age in the paper industry, and is one of the factors which warrant a more or less sophisticated discussion of some of the concepts behind the use of control charts. Most of the writers on the subject consistently have taken a very liberal view toward the application of engineering judgment and empirical evidence in modifying standard control chart procedures for paper mill application. Nothing can be found in Shewhart (*13*), Simon (*14*), Freeman (*15*), or Grant (*16*), or in the ASTM Manual (*17*), which is among the great pioneering works in quality control, to discourage such an attitude. It is consistent with the practical view of control methods observed during long association with industry. Therefore, this paper is intended as a straightforward exposition of a concept of applying sound and scientific principles.

Though the goal in all applications of control charts is much the same, the basic concepts involved as well as the specific procedures described sometimes seem divergent. This apparent divergence deserves critical analysis. It should be emphasized that it is believed that equally acceptable results may be obtained by alternative methods. There are as many differences between grades of paper and fiberboard and, indeed, between mills and individual paper machines, as there are between quality control engineers. One method may work for one set of conditions and a totally different one may be better for another setup. This difference may be particularly marked between engineers because of dissimilarities in temperament and in technical background. This may only tend to emphasize the true role of statistics in industry as a means of sharpening analytical acumen. Without the exercise of engineering judgment and without action, the performance of statistical routine is meaningless. The big question regarding any technique is whether it leads to effective technical improvements that are economical.

One of the salient facts in paper variation is that cross-machine effects are to a large extent independent of machine-direction effects. Few papermakers disagree with this. If this independence is real, there is no reason to believe that the inherent variations in the two cause systems are of the same magnitude. Even if they were, in the practical case beginning control limits (granting that we could, through an adequate engineering study, arrive at a rational basis for subgrouping) are not likely to be the same.

There is no justification, however, without engineering-statistical study, for assuming that inherent machine-direction variation is larger than corresponding cross-machine variation, rather than the other way around. This caution does not need to be expressed regarding control limits. One might consider the ability of the papermaker to control machine-direction variables such as changes in pulp preparation before the paper machine, shift changes of paper machine operators, rolls out of round, fluctuating head in the headbox pulsating flow through the slice, flow patterns on the wire, or changing machine speeds. The assessment of these variables could be contrasted to the probable variation in the cross-machine direction due to maladjustment of the slice, variation in roll diameter, or uneven calendering. If the grade of paper were also taken into account, one might arrive at some notions regarding the relationship between machine-direction and cross-machine variability.

CHOOSING RATIONAL SUBGROUPS FOR CHARTS

One might suppose that the usual procedure in setting up control charts would apply to paper machine control without adaptation. This would call for a set of limits for reel-end averages and cross-machine ranges based on the average range of the measurements taken across the paper web for each reel. There are valid objections to average chart limits set in this way because of the engineering considerations mentioned previously. The cause systems across and along the paper web are not the same and experience has shown that for many grades of paper the machine-direction variation is much larger,

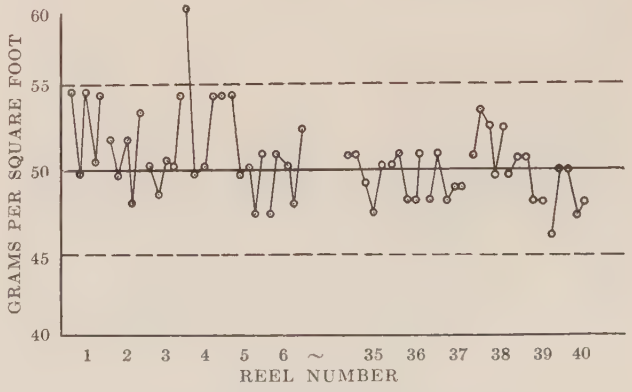

Fig. 1. Basis weight of paperboard—individual tests—limits based on cross-machine ranges

Cross-machine position: (1) front, (2) front middle, (3) middle, (4) back middle, (5) back.

at least in the beginning of the control program, than the cross-machine variation. Therefore, it has been most satisfactory to use a different basis for the control limits for reel ranges and for reel averages.

There may be objections in some cases to using unadjusted cross-machine ranges even for control across the machine. This is due to the frequent occurrence of bias in measurements from side to side of the paper machine. The author has recorded that cross-machine bias may result in an observable and even in a significant pattern. However, the pattern does not inflate cross-machine variation to a serious extent in all paper machine control problems. For example, the cross-machine variation in a grade of paper with which the author has worked has been uniformly well controlled. When lack of control has occurred, it has been due to excessive range and not due to the small bias effect. The pattern often changes quickly from reel to reel. This phenomenon is so interesting that Fig. 1 has been prepared showing the cross-reel pattern for a few of the 40 reels in the set of data used in reference (*5*) and reproduced in an appendix to this paper. The individual tests are all in control except for one measurement in the fourth reel. This reel was out of control also on the conventional range chart (not shown) and was the only instance of lack of control. It should be noted, however, that reel no. 4 has a pattern unlike any of the others. The assignable cause of lack of control is not the cross-reel bias. It looks as though this one test is a maverick. The typical pattern for this run is the one shown for reel no. 35. The basic cause of lack of control in this run is the long cyclic swing down, then up, then down again during the run. The individual chart used in Fig. 1 is insensitive to this kind of trend. The reel-end average chart, Fig. 2, gives a good picture of the trends throughout the run. It is out of control for the first reel. Even if one had been alerted to wait for trends, it would have been some time before the chart of Fig. 1 would have given a warning of this kind.

It is interesting to note a few more things about these charted data. If five consecutive machine direction measurements at a time are averaged for each of the cross-machine positions and the eight patterns thus obtained for 40 reels are plotted, Fig. 3 results. This chart has the useful property of portraying the typical pattern more often than not. The pattern of the second set is typical of the whole run. This chart also

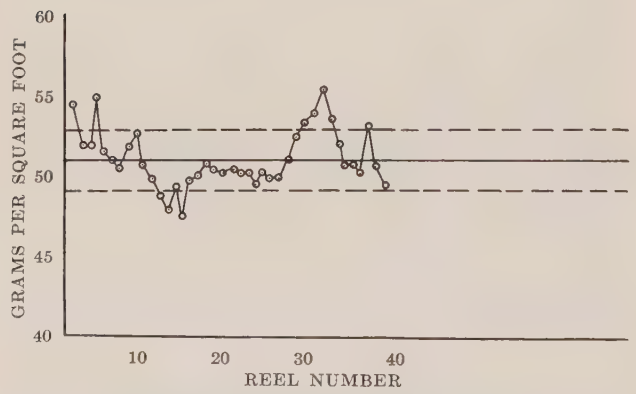

Fig. 2. Basis weight of paperboard—reel-end averages—2σ limits based on moving range

⊙ = Average of five cross-machine tests.

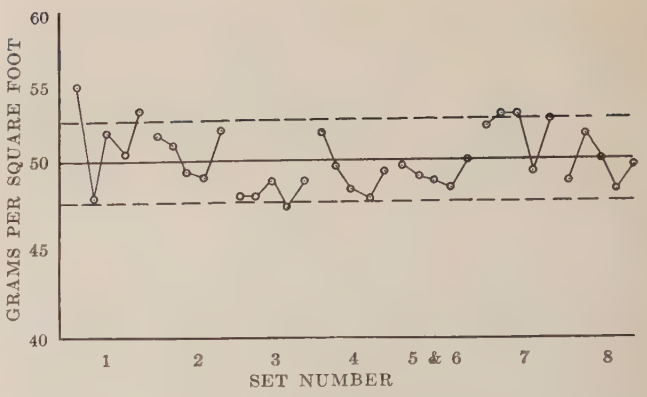

Fig. 3. Basis weight of paperboard—averages—5 reels at each cross-machine position

Cross-machine position: (1) front, (2) front middle, (3) middle, (4) back middle, (5) back.

indicates lack of control at exactly the same times as does the average chart of Fig. 2. The unfortunate thing is that lack of control is again due to the trends (reel-to-reel effects) and not to the pattern. Correction for the kinds of patterns shown, the nature of which is hard to conceive in most instances, would have contributed little to reducing the over-all variability of this run. It is notable that some of the things that must be done to correct lack of control across the machine or to correct a cross-machine bias are beyond the capacity of the operator during a run. A simple adjustment of the slice would probably not have helped much with any of the patterns recognized during this run.

Another possibility considered by some paper mill people is the use of a separate chart for each cross-machine position. This has interesting possibilities, and if one is worried about cross-machine variation perhaps it should be done, although it multiplies the number of charts by the number of positions tested.

For paperboard, machine direction variability has seemed to be consistently large and in poor control compared to cross-machine variability. Even when cross-machine bias has been present, the cross-machine component of the total variance has been small. This results in control limits that are very narrow when conventional average charts are used. Reel averages exceed the limits an excessive portion of the time and often exceed specification limits in data that are available from operations before the use of statistical quality control. The data often indicate cyclic and other types of instability typical of uncontrolled processes. The disturbances may be external to the paper machine, and most of them probably are. They arise from human foibles in handling of the machine, changes in shifts, adjustments by the papermaking "artist," and from occurrences ahead of the machine, like changes in formulation or treatment of stock between beater loads, or consistency changes and the like. On the premise that one should put out the big fires first and gradually narrow limits as more and more causes are identified and removed, a control chart is needed that will point out the gross human errors.

This leads up to the reasons for using a moving range. In choosing a point of departure, a risk is incurred of a conflict in philosophy. Shewhart and his outstanding followers present as the purpose of subgrouping not the

minimization of variation but the inclusion of some rational component of the total variation which will enable one to take intelligent action in directions determined *a priori* on engineering grounds. These same engineering considerations prevent one from using minimized variation as a measure of process capability without due consideration of the difficulty and expense of removing assignable causes. The difficulty and the expense are grave considerations in paper machine control. Furthermore, if chemical analyses or other variable physical tests like the densometer test or printability tests are involved, it is necessary to obtain proof that minimized variability is not just test variability.

From the standpoint of practical use, a control chart is of more harm than good if, (1) it never indicates cause for action, or (2) it indicates cause for action with high frequency. In the latter instance the operator is not helped to improve the bad habits of dispersion of effort and overcontrol of the process which the quality control engineer is trying to correct. In the experience of the chemical industry, and of the pulp and paper industry, it has almost always been necessary to modify the conventional control chart limits. Progress has been made gradually toward the ultimate limits which show the process in control and measure its capability. At any stage, the basis for subgrouping must be realistic from the technical viewpoint and be consonant with economic limitations. The moving range is a rational way of achieving this. It has some faults, principally because of the long time elapsed from one reel end to the next, but it applies corrective action in realistic sequence to an *a priori* engineering objective that makes sense. It is, for the purpose intended, a rational method of subgrouping. Over the long run it will bring the machine closer and closer to the inherent machine direction variability determined within a reel. It is capable of bringing the process into control safely within specifications. If it is desired to narrow the variability further, it will be necessary to determine new rational groups based on within-reel variability.

A comment may be made concerning the probability levels to be chosen in setting chart limits because of the practice of using narrower than standard limits when moving ranges are used. The use of two sigma limits or limits at any other multiple of sigma is a matter of economics. To look upon it as a matter of expedience is to overlook one of the tenets of Shewhart's method. The control chart method is a method of economic control. Throughout the chemical industry, particularly in batch processes, and in the pulp and paper industry, the economy of two sigma limits is recognized. It is worth while to look for assignable causes five times out of a hundred when they do not exist if the penalty for failing to find a real cause of variation is great. The implications of a change in limits are administrative, but it should not be considered outside the professional responsibility of the quality control engineer to recommend such changes.

The increment change from reel to reel for the moving ranges of Fig. 2 is very small and is indicative of a better than usual beginning degree of control. However, when two sigma limits from moving ranges are used, lack of control is picked up one or two reels earlier than it would have been if conventional average chart limits had been used for two out of the three times that trouble occurred during the run. This is the kind of a control chart to produce action quickly, to do it just often enough, and to point out the really important cause of variability. This is so because the chart has been designed consciously to bring out the kinds of human errors and machine variations that our experience and engineering knowledge have led us to believe not only exist but also are important.

SUBGROUPS BASED ON WITHIN-REEL VARIATION

In the past, there has been one good way to get at the comparison of inherent variability in paper in the cross-machine and machine directions. It meant a lot of work and great expense that had to be repeated from time to time and for every grade of paper and every individual machine. This was to cut up a reel of paper and analyze the internal variation. Or, if the paper was being cut up into sheets, it was sometimes possible to arrange to sample so as to retain information on the order of production. However, new types of controls, such as beta gages, now make it possible to tie in cross-machine basis weight variations with slice adjustment and to pick up significant information about within-reel variation in the machine direction. The author relied on the results of cutting up a reel of paper for a comparison of cross-machine and machine-direction variation described in reference (*6*). A statement in that paper implies something about inherent variability in the machine direction: "The control limit spread for wire-length to wire-length variation is the same as calculated for variation within one wire length, indicating that these variations are of the same magnitude." Here, then, is an expression of inherent machine-direction variability. There are two things that must be taken into consideration before accepting these within-reel subgroups as rational. The first is the possibility that the samples may have been taken so close together that the test results are serially correlated. This is a very serious consideration indeed, for a bulk material like paper. However, the 70-ft. spacing of samples for the between wire-length groups is adequate to dispel the suspicion of serial correlation. The second consideration is the inflationary effect on variation of the existence of cyclic fluctuations in the data. The subgroup must be taken in a period of time that is short compared to the period of any significant cycle. The illustration used in the paper is not perfect in this respect, but the similarity of control limits for within wire length and for between wire length leads to acceptance of the result.

Within the restrictions imposed by the nature of the material being sampled and tested and the machine system being controlled, this within-reel variability will eventually be minimized. It may eventually be of the same magnitude as cross-machine variation, but the engineer must guard against weaknesses which may arise from the sources enumerated. The principal weaknesses are those which may arise due to short-term cycles, to sampling difficulties leading to serial correlation of results, or due to excessive variability of some of the test methods used in the paper industry.

RANDOMNESS OF PAPER MACHINE SAMPLES

Much has been said about the randomness of paper machine sampling, a great deal of it without cognizance

of many sound comments made on randomness by Shewhart (*13*) and Simon (*14*). Shewhart has emphasized, with very good reason, that a random sample is one that is selected by a random operation. A sample has been selected in a random manner when all articles constituting the universe were equally likely to be selected during the sampling process. The processes involved in the normal sampling from a paper machine are not random processes whether considered from the standpoint of machine direction or cross-machine direction. In the long run, the machine-direction samples amount to a random sample, but have the shortcoming that one has no completely satisfactory basis for grouping them for control purposes. It is erroneous to think of the usual methods of cross-machine sampling as ever being a random operation. It is not true that if the universe to be sampled is homogeneous with respect to the measured variable that any sample, no matter how it is selected, is a random sample. Cross-machine samples are usually not random because they are usually not selected by a random operation. The stratified samples obtained across a machine are subject to bias. If this bias is of sufficient magnitude to result in lack of control, or if it affects ability to meet specification limits it should be corrected at an early stage. However, when sources of variation exist that have far greater effects on process control, the problem of cross-machine bias may be relegated to secondary importance.

CONCLUSIONS

If control charts are to be used successfully, they must be so devised as to help point out the positive action necessary to correct assignable causes of variation. They must be simple enough for nontechnical people to use and understand. The control charts cannot be looked upon as ends in themselves, but must become a part of a mill-wide, or even company-wide, program which is kept before the whole organization constantly, just as safety or any other important program is constantly supported.

LITERATURE CITED

1. Catlin, J. B., *Paper Ind.* 26: 717–720 (Sept., 1944).
2. Noble, Carl E., *Industrial Quality Control* 8, No. 3: 17–22 (Nov., 1951).
3. Bicking, Charles A., *Paper Trade J.* 124, No. 17: 63–67 (April, 1947).
4. Bicking, Charles A., *Pulp Paper Mag. Canada* 49, No. 3: 181–188, 195 (Feb., 1948).
5. Bicking, Charles A., and Trelfa, R. T., *Tappi* 34, No. 8: 370–380 (Aug., 1951). "Part II," *Tappi* 38, No. 9: 413–418 (Sept., 1952).
6. Bicking, Charles A., and Trelfa, R. T., "Some Influences of Paper Machine Design and Operation on Variability of

APPENDIX

Table I. Basis Weight of Paperboard Before Start of Quality Control System

(Pounds per 1000 sq. ft.)

Reel no.	*Front*	*Front middle*	*Middle*	*Back Middle*	*Back*	*Reel average*	*Reel range*	*Moving range of reel averages*
1	56	49	56	52	55	53.6	7	
2	53	49	53	49	54	51.6	5	2.0
3	51	49	52	51	55	51.6	6	0
4	61	50	51	55	55	54.4	11	2.8
5	55	50	51	48	52	51.2	7	3.2
6	48	52	51	49	54	50.8	6	0.4
7	53	50	48	49	53	50.6	5	0.2
8	53	51	53	50	51	51.6	3	1.0
9	54	54	49	52	52	52.2	5	0.6
10	52	51	49	49	52	50.6	3	1.6
11	48	52	49	48	51	49.6	4	1.0
12	50	48	49	50	48	49.0	2	0.6
13	48	48	48	48	49	48.2	1	0.8
14	51	48	50	47	50	49.2	4	1.0
15	46	47	51	45	49	47.6	6	1.6
16	53	51	49	47	48	49.6	6	2.0
17	52	49	48	51	49	49.8	4	0.2
18	52	51	50	49	51	50.6	3	0.8
19	53	49	50	47	51	50.0	6	0.6
20	52	51	48	47	51	49.8	5	0.2
21	53	48	50	50	50	50.2	5	0.4
22	50	50	49	48	53	50.0	5	0.2
23	48	52	50	49	51	50.0	4	0
24	50	51	49	47	50	49.4	4	0.6
25	51	48	50	51	50	50.0	3	0.6
26	50	51	49	48	51	49.8	3	0.2
27	50	48	47	49	50	48.8	3	1.0
28	53	52	50	49	50	50.8	4	2.0
29	53	53	50	50	54	52.0	4	1.2
30	53	54	53	50	54	52.8	4	0.8
31	54	51	54	54	54	53.4	3	0.6
32	55	58	56	51	56	55.2	7	1.8
33	53	55	54	49	53	52.8	6	2.6
34	52	53	54	48	52	51.8	5	1.0
35	52	52	50	48	51	50.6	4	1.2
36	51	52	49	49	52	50.6	3	0
37	49	52	49	50	50	50.0	3	0.6
38	52	55	53	50	53	52.6	5	2.6
39	50	52	52	49	49	50.4	3	2.2
40	47	51	51	48	49	49.2	4	1.2
				Totals		2032.0	181	41.4
				Averages		50.8	4.53	1.035

Paperboard," submitted to *Industrial Quality Control*, 1953.
7. Dreshfield, Arthur C., *Am. Paper Converter* 22, No. 5: 10–11, 15–16 (May, 1948).
8. Koon, Charles M., and Pease, W. F., *Tappi* 32, No. 6: 253–258 (June, 1949).
9. Langmaid, J. F., Jr., and Cobb, H. W., *Tappi* 33, No. 10: 485–486 (Oct., 1951).
10. Milne, K. C., *Pulp Paper Mag. Canada* 52, No. 11: 103–109 (Oct., 1951).
11. Patte, W. E., *Pulp Paper Mag. Canada* 50, No. 9: 87–91 (Aug., 1949).
12. Purcell, Warren R., *ASQC Conference Papers*, pp. 51–53 (May, 1952).
13. Shewhart, Walter A., "Statistical Method from the Viewpoint of Quality Control," The Graduate School, Department of Agriculture, Washington, D. C. (1939).
14. Simon, Leslie E., "An Engineer's Manual of Statistical Methods," New York, N. Y., John Wiley and Sons, Inc., 1941.
15. Freeman, H. A., "Industrial Statistics," New York, N. Y., John Wiley and Sons, Inc., 1949.
16. Grant, Eugene L., "Statistical Quality Control," New York, N. Y., McGraw-Hill Book Co., 1946.
17. "ASTM Manual on Quality Control of Materials," American Society for Testing Materials, Philadelphia, Pa., 1951.

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Application of Refining Energy Index Concept to Experimental Evaluation of Strength-Yield Relations for Hardboard Stocks

H. DALE TURNER

Steam-cooked Douglas-fir pulps in yields ranging from 68 to 96% were refined for hardboard stocks in a 5-hp. single-rotating-disk refiner. Data for time-temperature-yield relations are presented, together with pulp drainage times and corresponding hardboard strength values. The ratio of hardboard bending strength to energy consumed in refining, called the energy index, is shown to be significant in rationalizing a wide dispersion of strength-yield data. The energy index increases directly with decreasing yields. The theoretical energy demand-strength relation indicates a rapid decrease in energy consumption with decreasing yields down to approximately 85% but a comparatively minor decrease for yields below 80%.

Steam cooking of wood and other fibrous materials is an established practice in the production of coarse fiber for a variety of end products. In fact, the marked decrease in interfiber bond strength of wood in a steam atmosphere was the basis for the development of a unique fiber-production machine used extensively in the manufacture of coarse fiber for building papers, insulation bats, and structural fiberboards (*1*).

The digestion processes of water or steam cooking, alone or in combination with certain pulping reagents, produce a variety of effects that influence wood fiber's response to processing, plant operational characteristics, and quality of the final product. The effects on wood composition during steam and water cooking have been investigated by several groups (*2, 3*). Campbell has given a theoretical discussion of some of the factors involved in the fiber-water relation (*4*) and an approach to measuring some of the fiber quality characteristics has been reviewed by Clark (*5*).

The purpose of this paper is to apply the energy index concept to the determination of the relation between steam-digestion conditions, fiber response to refining, and pulp strength development in the form of hardboard. The energy index is the ratio of the board strength to the energy consumed in refining the hardboard stock (modulus of rupture in pounds per square inch/kilowatt-hours per ton of dry fiber).

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PROCEDURE AND EXPERIMENTAL EQUIPMENT

The steam digestions were conducted with a single lot of second-growth Douglas-fir. The partly dry chips were immersed in water for about 24 hr. and then drained to a solids content of about 43%.

The Douglas-fir chips were cooked in a rotating, stainless steel digester of 2-gal. capacity. The digester was preheated before each cook, and, at the start of the cycle, the pressure was partly relieved several times. A thermometer well projecting into the digester and a pressure regulating valve on the steam supply line permitted accurate control of the digestion temperature. Steam was admitted directly to the digester chamber, which contained 1 kg. of wood, dry basis. The minimum feasible cooking time was 2 min. at the higher temperatures; with shorter cooking times the reproducibility of digestion conditions was difficult.

The cooked chips were drained, cooled, and reduced to splinterlike particles using plate A (Fig. 1) in the 5-hp., single-rotating-disk refiner shown in Fig. 2. The product from this grind was processed using plate C (Fig. 1). Duplicate cooks were milled at plate clearances of 0.002 and 0.010 in. in order to provide two degrees of refining. The rate of water flow to the mill was held constant in all trials, and the rate of chip feed was manually controlled so as to maintain a full motor load.

The net energy consumed in milling each lot was measured by means of a watt-hour meter. No corrections were made for motor losses or other power dissipations occurring during refining.

The refined stock was collected in an 80-mesh screen-bottom box, dewatered to a solids content of about 15% on a suction box, and divided into lots for preparation of hardboard panels and the drainage test.

The appropriate weight of dewatered stock was diluted to approximately 1.5% consistency, agitated a few

minutes, and formed into a 10-in. square sheet on a suction box. Sizing of the boards was omitted in this investigation, since its effect on strength is sometimes erratic. The mat was then cold-pressed at a pressure of 500 p.s.i. for 2 min. and subsequently hot-pressed at 500 p.s.i., 160°C. for 20 min. The dried panel was immediately weighed and subsequently conditioned for about 30 days at 65% relative humidity, 75°F. before testing.

TESTING PROCEDURE

The drainage test was conducted with the Williams Precision Tester, and the observed drainage times were adjusted to correspond to the drainage time for an 8-gram sample.

Strength Test

The modulus of rupture of the hardboard test panels was determined according to American Society for Testing Materials tentative method D 1037–49 T. The span was varied in these tests to maintain an approximately constant span-depth ratio for the range in specimen thicknesses. Specific gravity was based on the specimen's weight and volume at the time of test.

Unit energy consumed in refining was calculated from the net kilowatt-hours consumed, including the preliminary chip reduction to splinters, and the total dry weight of processed fiber, based on the weight of the press-dried panels and the oven-dried drainage-test mats.

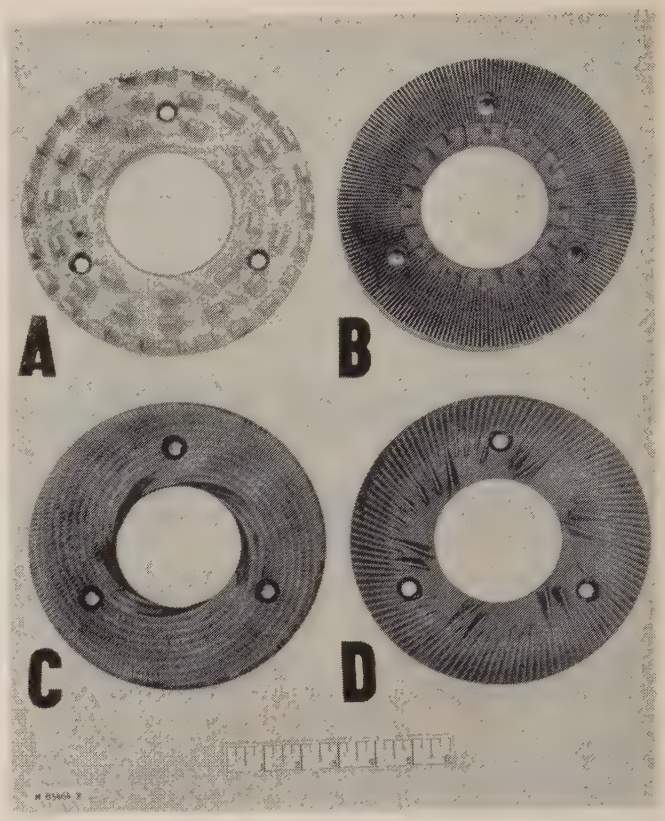

Fig. 1. Interchangeable plate designs employed in a single-rotating-disk refiner

Table I. Summary of Steam Cooking and Pulp Processing Conditions, Yield, Energy Consumption, and Drainage Test tion of Strength-Yield Relations for Steam-Cooked Douglas-Fir Hardboard

Pulp lot	Digestion temperature, °C.	Digestion time,[a] min.	Wt. of raw material, g.	Dry solids content, %	Wt. of oven-dry solids, g.	Wt. of pulp, dry basis, g.	Pulp yield[b]	Plate clearance, in.	Energy consumed,[c] kw.-hr.	Unit energy consumed, kw.-hr. per ton	Drainage (Williams test) — Wt. of sample, dry basis, g.	Drainage time — Observed, sec.	Drainage time — Adjusted to 8-g. basis, sec.	Panel A — No. of tests	Panel A — Av. specific gravity	Panel A — Av. modulus of rupture, p.s.i.
22	130	2	2245	44.5	1000	940	94.0	0.002	1.44	1390	8.49	43	39	3	1.13	6980
23	130	2	2245	44.5	1000	935	93.5	0.010	1.30	1260	8.05	18	18	3	1.11	5230
24	130	20	2245	44.5	1000	937	93.7	0.002	1.29	1250	8.00	21	21	3	1.14	6470
25	130	20	2245	44.5	1000	934	93.4	0.010	1.25	1220	8.55	17	15	3	1.09	4930
26	130	100	2245	44.5	1000	919	91.9	0.002	1.13	1120	8.06	22	22	3	1.14	6770
27	130	100	2245	44.5	1000	929	92.9	0.010	1.18	1160	8.18	13	13	3	1.10	5000
28	130	500	2245	44.5	1000	889	88.9	0.002	0.71	725	8.31	23	22	3	1.11	6320
29	130	500	2245	44.5	1000	892	89.2	0.010	0.73	745	8.18	17	16	3	1.09	5270
30	150	2	2405	41.7	1000	941	94.1	0.002	1.48	1340	8.20	52	51	3	1.09	6280
31	150	2	2405	41.6	1000	936	93.6	0.010	1.32	1280	9.11	14.5	12	3	1.03	3670
32	150	20	2405	41.6	1000	918	91.8	0.002	0.94	930	7.91	16	16	3	1.08	6130
33	150	20	2405	41.6	1000	921	92.1	0.010	0.87	860	7.91	12	12	3	1.06	5010
34	150	100	2405	41.6	1000	856	85.6	0.002	0.64	680	7.52	33	38	3	1.09	6450
35	150	100	2405	41.6	1000	866	86.6	0.010	0.52	545	7.56	13	15	3	1.13	5850
36	150	200	2405	41.6	1000	834	83.4	0.002	0.59	645	7.81	40	42	3	1.11	6580
37	150	200	2405	41.6	1000	830	83.0	0.010	0.45	495	8.03	16	16	3	1.10	5320
38	170	2	2292	43.6	1000	888	88.8	0.002	1.00	1020	8.41	21	19	3	1.14	7200
39	170	2	2292	43.6	1000	895	89.5	0.010	0.94	955	8.83	14	12	3	1.11	6470
40	170	10	2292	43.6	1000	845	84.5	0.002	0.59	635	7.87	20	21	3	1.14	8020
41	170	10	2292	43.6	1000	845	84.5	0.010	0.58	625	8.02	12	12	3	1.12	6470
42	170	20	2292	43.6	1000	799	79.9	0.002	0.56	645	7.48	27	30	3	1.13	7310
43	170	20	2292	43.6	1000	811	81.1	0.010	0.44	490	7.48	12	13	3	1.13	6460
44	170	100	2292	43.6	1000	763	76.3	0.002	0.43	515	9.60	48	35	3	1.14	4750
45	170	100	2292	43.6	1000	746	74.6	0.010	0.41	375	7.77	17	18	3	1.13	5310
46	190	2	2400	42.5	1020	866	84.8	0.002	0.72	755	7.97	23	23	3	1.13	8420
47	190	2	2400	42.5	1020	871	85.3	0.010	0.56	585	8.39	12	11	3	1.13	7100
48	190	10	2400	42.5	1020	808	79.2	0.002	0.48	540	7.75	31	36	3	1.14	5780
49	190	10	2400	42.5	1020	819	80.2	0.010	0.40	445	7.65	13	14	3	1.13	6770
50	190	20	2400	42.5	1020	781	76.4	0.002	0.30	360	8.15	42	41	3	1.12	6710
51	190	20	2400	42.5	1020	769	75.4	0.010	0.26	305	7.33	17	20	3	1.13	5940
52	190	100	2405	41.6	1000	679	67.9	0.002	0.28	375	9.32	92	74	3	1.15	6510
53	190	100	2400	42.5	1020	691	67.7	0.010	0.24	315	9.00	50	41	3	1.14	5860

[a] Digestion time is taken from time digester pressure corresponded to desired temperature to time blow-off valve was fully opened.
[b] Based on weight of press-dried panels.
[c] Includes energy consumed in initial coarse grind with plate A.
[d] Modulus of rupture adjusted to specific gravity of 1, based on ratio of squares of specific gravity values as given by the equation $S^2/S_1^2 = R/R_1$, where S is the computed strength at the specific gravity S_1 chosen as the basis for comparison.
[e] Energy index is: modulus of rupture, p.s.i./kilowatt-hours per ton of dry pulp.

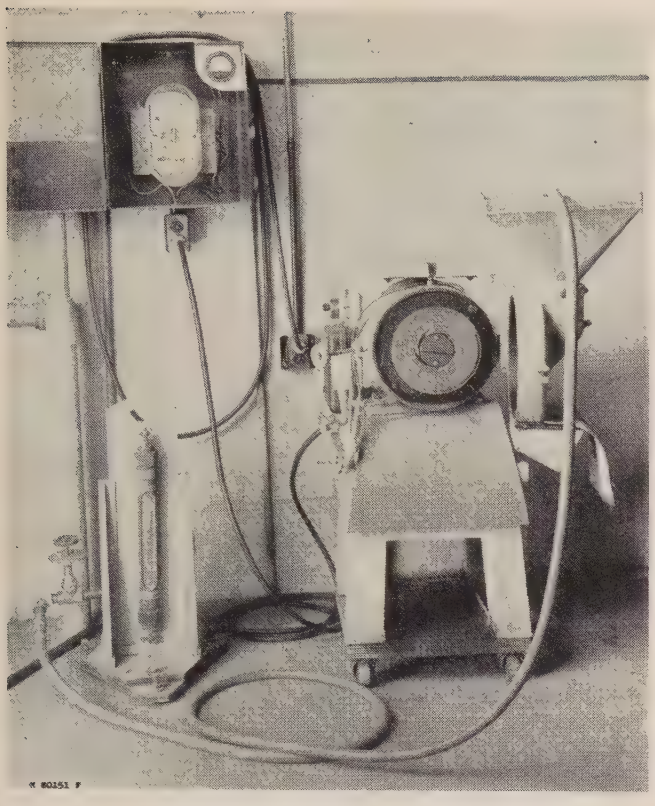

Fig. 2. A 5-hp., single-rotating-disk refiner

Watt-hour meter at upper left; water-flow meter at lower left

and Strength Data Obtained in Experimental Evalua-Stocks

Strength			Panel B			
Adjusted modulus of rupture, p.s.i.	*No. of tests*	*Av. specific gravity*	*Av. modulus of rupture, p.s.i.*	*Adjusted modulus of rupture,[d] p.s.i.*	*Av. adjusted modulus of rupture, p.s.i.*	*Energy index[e]*
5430	3	1.14	7130	5520	5480	3.94
4280	3	1.10	5220	4290	4280	3.40
4970	3	1.13	6210	4860	4920	3.94
4190	3	1.11	4680	3790	3990	3.27
5180	3	1.12	6010	4820	5000	4.46
4100	3	1.12	5120	4110	4100	3.53
5090	3	1.13	6420	5020	5060	6.98
4420	3	1.13	5860	4620	4520	6.07
5250	3	1.08	6760	5760	5500	4.10
3480	3	1.05	3930	3550	3520	2.75
5250	3	1.06	3860	3410	4330	4.66
4490	3	1.06	5240	4670	4580	5.33
5420	3	1.08	6390	5480	5450	8.01
4550	3	1.10	5510	4530	4540	8.33
5310	3	1.11	6600	5350	5330	8.26
4400	3	1.09	5410	4550	4480	9.05
5510	3	1.14	7550	5780	5640	5.53
5220	3	1.13	6380	5000	5110	5.35
6130	3	1.12	7790	6180	6160	9.70
5170	3	1.13	6260	4900	5040	8.06
5690	3	1.14	7870	6090	5890	9.13
5030	3	1.12	6180	4900	4960	10.12
3670	3	1.13	6190	4820	4240	8.23
4160	3	1.10	5040	4190	4180	11.15
6600	3	1.12	7880	6250	6420	8.50
5530	3	1.13	6980	5450	5490	9.38
4420	3	1.15	8090	6150	5280	9.78
5330	3	1.10	4110	3380	4360	9.80
5320	3	1.10	5120	4210	4760	13.22
4650	3	1.12	5590	4430	4540	14.89
4900	3	1.12	4780	3770	4340	11.57
4530	3	1.14	5790	4460	4500	14.29

and R are the observed values for specific gravity and strength and R_1

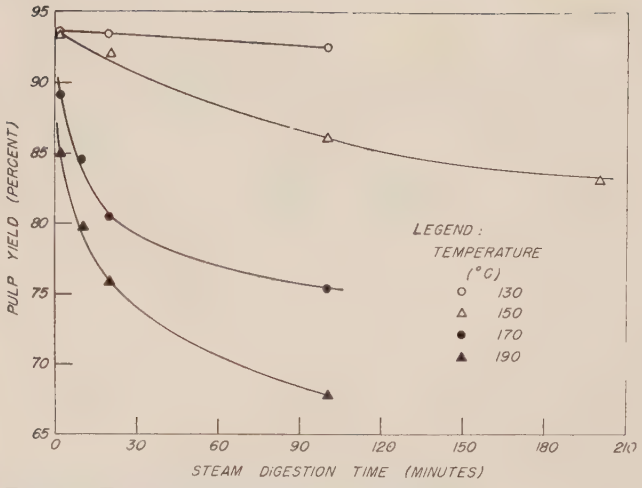

Fig. 3. Effect of steam digestion conditions (time and temperature of cooking) on pulp yield from second-growth Douglas-fir

PRESENTATION OF RESULTS AND DISCUSSION

A summary of the experimental data is given in Table I. A graphical review of the time-temperature-yield relation is presented in Fig. 3. This family of curves emphasizes the influence of elevated steam temperature on wood degradation; a 5-min. exposure at 170°C. is equivalent to 500 min. at 130°C., and 4 to 5 min. at 190°C. is equivalent to 200 min. at 150°C.

The plotted array in Fig. 4 indicates a weak correlation between yield and strength-drainage ratios of the refined stocks, but the dispersion of data doesn't warrant firm conclusions. The qualities of high strength and rapid drainage seem to attain an optimum in the yield range of 85 to 90%. The steepness of the initial slope of the curves implies that, in the yield range of 90 to 95%, for example, increase in board strength or decrease in drainage time (perhaps both simultaneously) is large for small changes in yield, whereas the changes in strength and drainage time are comparatively minor in the range of 85 to 90% yield.

The yield-strength relation cannot be accurately determined from relatively few refining runs. The observed data, adjusted to a comparable strength basis, are plotted in Fig. 5. Although these data tend to illustrate a maximum in strength in the range of 85% yield, the dispersion of the data again indicates the difficulties encountered in evaluating the optimum relation between yield and fiber processing.

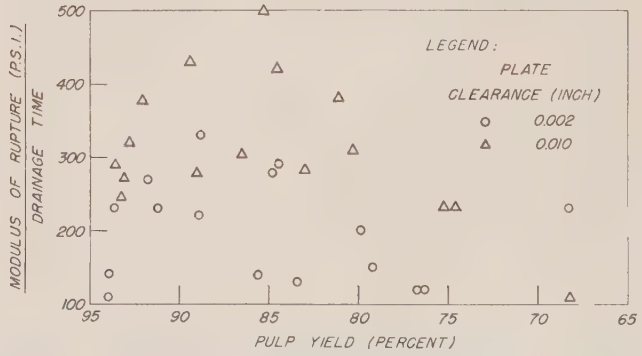

Fig. 4. Dispersion of data for pulp yield versus ratio of hardboard strength to pulp drainage time. The data correspond, approximately, to two different degrees of refining

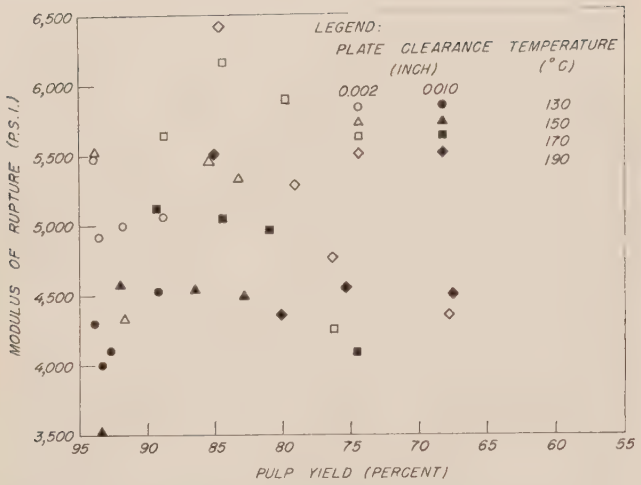

Fig. 5. Dispersion of data for pulp yield versus hardboard strength

Observed values for modulus of rupture were adjusted to a specific gravity basis of 1.00.

The same data, however, develop a striking relation when the influence of fiber processing energy is taken into consideration. The curve shown in Fig. 6 presents the energy index as a dependent variable of yield and includes a wide range of pulp qualities, yields from less than 70 to 95%, and observed hardboard strength values from about 3600 to 8000 p.s.i. The contrast between the correlation of data in this figure and the dispersion of data in Fig. 5 show the energy index to be of basic significance in the interpretation of yield-strength relations.

The curve of Fig. 6 suggests that the application of the energy index concept is a useful tool for measuring the effects of variables in the digestion procedure, fiber response to refining, and the effects of variables in the refining procedure when processing a uniform raw material.

A theoretical interpretation of the data given in Fig. 6 is shown graphically in Fig. 7. This curve is based on the calculated processing energy needed to develop a final hardboard strength of 5000 p.s.i. at a specific gravity of 1. For example, referring to Fig. 6, at 86% yield the energy index value is 8. If this value is substituted in the equation

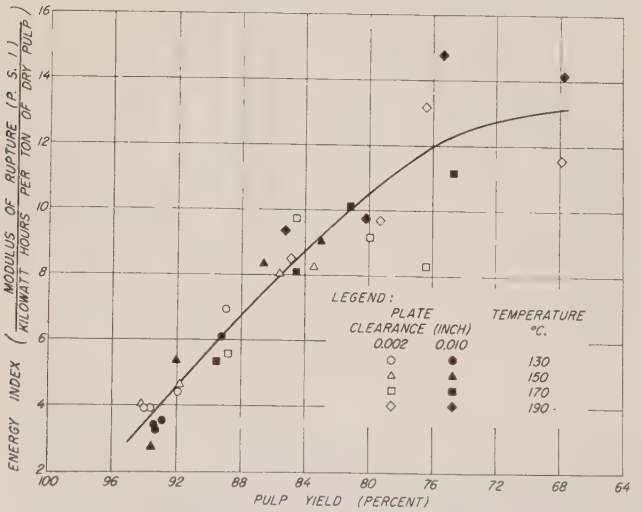

Fig. 6. Relation between pulp yield and energy index

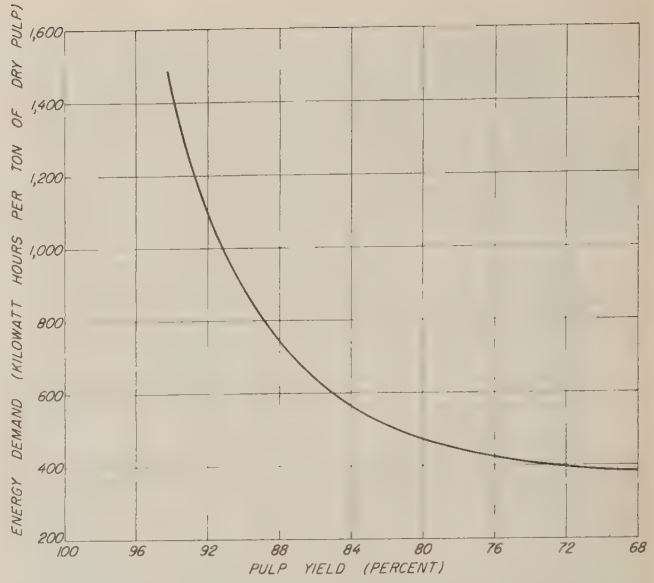

Fig. 7. Relation between pulp yield and calculated energy demand required for stock refining so as to produce a resultant hardboard modulus of rupture of 5000 p.s.i. (specific gravity basis, 1)

$$EI = \frac{R}{K}$$

where

EI = energy index
R = hardboard modulus of rupture adjusted to specific gravity of 1.00
K = kw.-hr. per ton (dry basis) of stock processed

then

$$EI = 8 = \frac{5000}{K}$$

$$K = \frac{5000}{8}$$

K = 625 kw.-hr. per ton

From the shape of the curve it is evident that the energy demand decreases sharply in the high-yield range, but below 80% yield, decrease in energy demand is negligible. The general nature of this curve may be useful in establishing an optimum economic balance between power and wood costs.

CONCLUSIONS

The interrelation of digestion procedures, yield, fiber processing conditions, and hardboard strength is difficult to establish on the basis of yield-strength data alone. The energy index concept is useful in correlating a dispersion of data into a relatively simple relation.

The yield-energy index curve shows good correlation in the yield range from 75 to 95% and adjusted strength values from 3600 to over 8000 p.s.i. This correlation appears to offer a method of basic importance for evaluating stock preparation procedures.

LITERATURE CITED

1. Asplund, A. J. A., Northeastern Wood Utilization Council, Bulletin 31 (Jan., 1950).
2. Aronovsky, S. I., and Gortner, R. A., *Ind. Eng. Chem.* 23: 3, 264 (1930).
3. McGovern, J. N., Brown, K. J., and Kraski, W. A., *Tappi* 32: 10 (Oct., 1949).
4. Campbell, A. B., Canada Forest Service Bulletin 84 (1933).
5. Clark, James d'A., *Tappi* 26: 285, 462, 499 (1943).

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A Comparison of Kraft and Neutral Sulphite Semichemical Pulps from Birch and Maple

D. J. MacLAURIN, J. R. PECKHAM, and W. B. WEBER

Kraft and neutral sulphite semichemical pulps have been prepared and bleached from a mixture of rock and white maple (*Acer saccharum* and *Acer saccharinum*) and a mixture of yellow and white birch (*Betula lutea* and *Betula papyrifera*). Unbleached yields were about 50 to 52% for the krafts, 65 and 70% for the maple semichemical, and 70 and 75% for the birch semichemical. With an arbitrary three-stage (chlorination-caustic extraction-calcium hypochlorite) bleach to about 80% G.E. brightness, the chlorine requirements were about 3 and 7% for the maple and birch krafts, respectively, 14 and 18% for the maple semichemicals, and 14 and 20% for the birch semichemicals. Bleached yields were 49 to 50% for the krafts, 51 and 53% for the maple semichemical, and 58 and 59% for the birch semichemical. The birch was more difficult to pulp than the maple, particularly by the semichemical process. Trends indicated that for the same pulping conditions, birch gave a higher yield of stronger pulp. For equal yields it appears easier to bleach birch semichemical than maple semichemical, and maple kraft than birch kraft. At 700-ml. Schopper-Riegler freeness, all the pulps had useful strengths. The unbleached kraft pulps were stronger, easier bleaching, and considerably harder to beat than the unbleached semichemical pulps. Bleaching lowered the kraft and raised the semichemical strengths so that the bleached semichemical pulps were stronger than the bleached kraft pulps and about equal to the unbleached kraft pulps. Bleaching did not affect the beating characteristics of the kraft pulps. The bleached semichemical pulps were much easier to beat than the unbleached semichemical pulps. All bleached semichemicals contained many colored shives. All bleached birch pulps and the bleached higher yield maple semichemical pulps had low opacity. All of the pulps appeared potentially suitable for selected grades of paper.

THESE studies were made to determine the conditions and results of pulping and bleaching mixtures of white and rock maple and white and yellow birch, within given commercial limitations, by both the kraft and neutral sulphite semichemical processes, with the general objective of producing paper grades of bleached pulps. While the findings are not necessarily optimum, the data are probably sufficiently comprehensive to give good general information on these species of increasing interest.

RAW MATERIALS

Sound, bark-free sticks were chipped on a 48-in., four-knife chipper to nominal $^5/_8$-in. chips, and screened over a 4-mesh screen; knots and large pieces were sorted out and discarded. The maple was about 50/50, white/rock with a moisture content of 9.3%. The birch was 65/35, yellow/white with a moisture content of 15%.

The kraft liquor was prepared from commercial sodium hydroxide and purified sodium sulphide crystals, the neutral sulphite liquor from C.P. sodium sulphite and C.P. sodium bicarbonate. No spent liquors were incorporated in the cooking liquors.

PULPING PROCEDURES

The kraft pulps were cooked in a vertical, stainless steel digester of 44-liter capacity. This digester was equipped with manual controls and a heat exchanger through which the liquor was circulated at about 15 liters per min. At 100°C. all kraft cooks were gas relieved to 0 p.s.i. Just before beginning the relief for blowing, black liquor samples were taken through a cooler. Total and active alkali and pH were determined on these samples. Total alkali was determined conductometrically (TAPPI Standard T 625 m-48) and active alkali by titration of the barium chloride-treated liquor to pH 8.3 in the presence of formalin (*1*). At the end of the cook, digester pressure was relieved to 80 p.s.i., and the digester contents blown into a wooden blow tank fitted with a perforated stainless steel false bottom.

The pulp was retained in the blow tank for the washing operation which consisted of three consecutive dilutions with warm water. In the first wash, the pulp was stirred for 10 min. with a Patterson Unipower stirrer, after which the water was removed through the perforated false bottom and replaced with fresh water. After stirring the contents for 5 min., this water was drawn off and again replaced with fresh water which was drained without stirring. The effluent from the washings was passed through a muslin-covered washbox to trap the fines. These fines were returned to the blow tank after each of the first two washings. After the third wash, the fines were collected, oven dried, weighed, and discarded. Their weight is included, however, in the screened yield.

The maple semichemicals were cooked in a pair of externally gas-flame-heated, horizontal rotary cylindrical steel digesters of about 40 liters capacity, which were turned at 1 revolution in 3 min. Just before beginning the relief for dumping, black liquor samples were drawn through a cooler. Apparent sulphite was determined iodimetrically in the presence of ice. Also, the pH of these samples was measured. At the end of the cook, pressure was relieved to 0 p.s.i. and the chips transferred to a muslin-covered washbox to drain off free liquor. The birch semichemicals were cooked in a close-fitting basket in the same digester as the kraft

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pulps but otherwise by the same procedures used for the maple semichemicals.

All the semichemical chips were defibered while still hot in a commercial size Bauer refiner equipped with 36-in. disks fitted with B-957 plates and driven by two 100-hp motors. The refiner feed mechanism was a spiked roll with a Reeves drive. The feed rate range was divided into seven increments with a setting of 1 indicating the slowest feed rate and a setting of 7 indicating the fastest rate. The maple chips were given one pass through the refiner at a clearance of 0.003 in. between the plates and a final consistency of slightly over 8.0% (moisture-free basis). A second pass was not used on any of the maple pulps, but in one case, the screening rejects were given another pass through the pulper. This defibering technique appeared to produce excess fines with the birch pulps; hence a two-stage treatment was used, involving a first pass at 0.050 in. and a second pass at 0.002 in., with a between-stage thickening to about 10 to 12% moisture-free on a muslin-covered washbox.

The kraft pulps (after washing in the blow tank) and the semichemical pulps (after defibering in the Bauer pulper) were handled in the same way. They were screened on a laboratory-model Valley flat screen. The fibers which passed through a 0.010-in. cut plate were passed over an inclined screen covered with muslin, and the partially dewatered pulp was further thickened in a muslin-covered washbox. The white water which passed the inclined screen was caught in a fine muslin-covered washbox and any fines present were collected, oven dried, weighed, and discarded. Their weight is included in the screened yield figure. The weight of the rejected fraction is recorded as screenings in the yield data and is part of the unscreened yield.

After screening, the pulp was dewatered further in a fruit press, to about 25% solids; the cake of pulp was defibered, and a representative sample was removed for a moisture content determination. The pulp was weighed and the yield was determined. In the case of the kraft pulps, a representative sample was also removed for a permanganate number determination. These determinations were made according to TAPPI method T 214 m-50 using 25 ml. of permanganate.

The unscreened yield is the total moisture-free weight of fiber obtained, expressed as a percentage of the moisture-free weight of chips cooked. The screened yield is the total moisture-free weight of fiber obtained, less the moisture-free weight of screening rejects, expressed as a percentage of the moisture-free weight of chips. The screenings is the percentage of screening rejects based on the total moisture-free weight of fiber obtained. Kraft pulping data are given in Table I and semichemical pulping data in Table II.

To obtain adequate supplies of pulp for bleaching experiments and physical evaluations, duplicate cooks were made whenever satisfactory conditions were achieved. Thus, cooks 1 and 3, 8 and 12, 2 and 11, 14 and 15, 18 and 20, 22 and 25, and 26 and 27 were thoroughly mixed and treated as one pulp. The properties of pulps from selected cooks are summarized in Table III.

BLEACHING PROCEDURES

A three-stage bleaching sequence comprising a chlorination at 3% moisture-free consistency and 20 to 23°C., a caustic extraction at 12% moisture-free consistency and 50°C. for 1 hr., and a calcium hypochlorite bleach at 5% moisture-free consistency and 28°C. for 4 hr. was used in all the bleaching experiments. The desired brightness was 80 ± 2% G.E. These conditions were arbitrarily chosen to suit certain existing mill equipment and requirements, but they are not necessarily optimum in any sense.

In order to conserve the supply of an experimental pulp, bleaching trials were first run on small batches to establish conditions. Then a bleach was carried out on a large batch to provide sufficient pulp for beater runs. For the larger batches (750 grams), chlorinations were done in a rubber-lined chlorinator tower (18 by 13 in.) equipped with a 7-in. central draft tube and propeller for circulation. Gaseous chlorine was metered through a rotameter, then led in through a glass tube to the lower end of the draft tube. For all maple pulps, chlorinations were carried to practical exhaustion. However, the subsequent birch chlorinations were given 45 min. maximum retention time. The caustic extraction and hypochlorite stages were made in a jacketed, glass-lined, planetary-type laboratory mixer of approximately 20 liters capacity. The reaction mass temperature was maintained by circulating water through the jacket from a controlled temperature water bath. For the smaller batches (100 grams), chlorinations were carried out in an all-glass counterpart of the rubber-lined chlorinator, and the subsequent stages in beakers.

Preliminary bleaches made on the neutral sulphite pulps disclosed that dark specks remained after com-

Table I. Kraft Pulping Data

Cook ⟶ / *Wood* ⟶	*1* *Maple*	*3* *Maple*	*4* *Maple*	*5* *Maple*	*6* *Maple*	*7* *Maple*	*8* *Maple*	*12* *Maple*	*16* *Birch*	*18* *Birch*	*20* *Birch*
Active alkali (as NaOH), %	23.9	23.9	23.9	23.9	23.9	22.0	22.0	22.0	22.0	22.5	22.5
Sulphidity, %	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Water ratio (moisture-free basis), ml./g.	4	4	4	4	4	4	4	4	4	4	4
Max. temp., °C.	173	173	173	172	172	160	160	160	160	160	160
Time to max. temp., min.	90	90	90	150	150	90	120	120	195	195	195
Time at max. temp., min.	120	90	60	90	30	150	160	160	165	165	165
Time of final relief, min.	15	15	15	15	15	0	0	0	0	0	0
Total time (cover to blow), min.	225	195	165	255	195	240	280	280	360	360	360
Permanganate no.	9.5	9.5	10.0	8.4	10.6	11.3	12.2	11.8	11.5	10.7	11.2
Unscreened yield, %	47.8	48.1	48.1	48.3	47.8	49.6	50.6	50.1	52.6	52.3	52.3
Screened yield, %	47.4	47.5	47.0	48.1	47.3	48.2	49.0	47.9	52.5	52.2	52.2
Screenings, %	0.7	1.2	2.3	0.3	1.1	2.8	3.0	4.3	0.1	0.1	0.1
Black liquor data											
pH	12.6	12.8	12.8	12.8	12.9	11.5	11.5	12.6	12.6	12.6	12.8
Total alkali (as Na_2O), g./l.	41.0	41.3	41.8	47.6	41.6	40.2	41.7	38.7	35.7	36.2	36.0
Active alkali (as Na_2O), g./l.	7.2	6.6	8.3	8.1	9.3	6.8	8.3	7.6	8.1	9.2	8.7

pletion of the third stage. These were apparently knots of unbleached pulp which may have been caused by excessive squeezing of the pulp after screening. It was found that these knots could be adequately dispersed by circulating the stock in the small glass chlorinator with the stirring mechanism of a British disintegrator. The stirring was carried out at 3.5% moisture-free consistency for 50,000 revolutions. For disintegration of pulp for the large bleaches, the TAPPI standard disintegrating disk was used (T 200 m-45) on the shaft of a Model C2 Lightnin' mixer. This disintegration was carried out at 3% moisture-free consistency in the rubber-lined chlorinator. Similar difficulty was also experienced with the kraft pulps but soaking overnight at 3.0% moisture-free consistency was found to be adequate to insure dispersal of the pulp in the chlorinator.

After each stage of both the large and small batches, the pulp was thoroughly washed with filtered tap water. A muslin-covered washbox was used for the large bleaches and a 23-cm. Büchner funnel was used for the small bleaches. Before the caustic extraction stage, the chlorinated pulp was washed with sufficient hot water to raise the temperature of the pulp to that desired for the second stage. After the second and third stages of the large bleaches, moisture samples of the pulp were taken and yield determinations made.

Bleach requirement tests were made according to TAPPI method T 219 m-48, with the exception that the temperature, time, and consistency were the same as for the hypochlorite stage of the large bleaches. Brightness determinations were made according to TAPPI methods T 217 m-48 and T 218 m-48. In all, some 60 bleaching runs were made but bleaching data for the concluding bleaches only are given in Table IV.

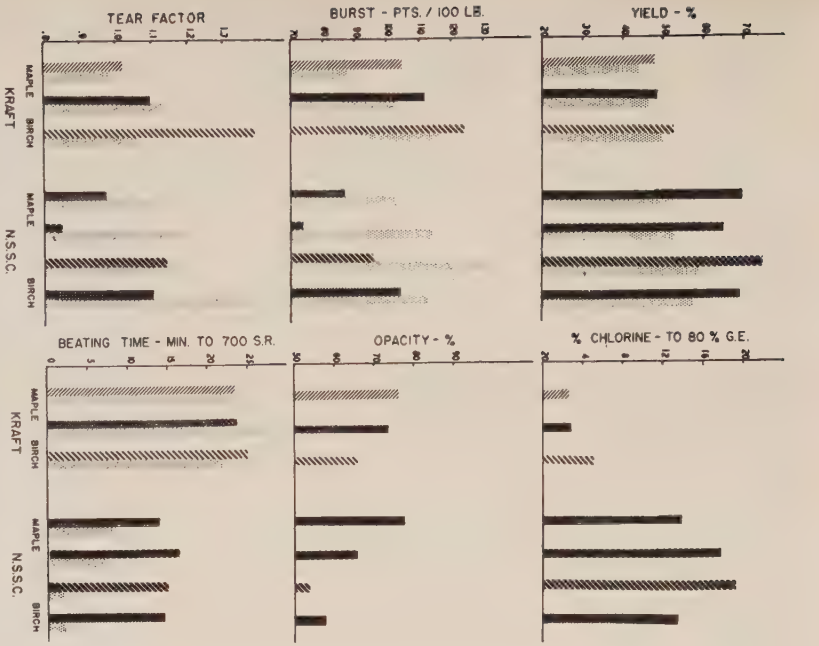

Fig. 1. Pulp yields and properties (bleached pulp values are to the right in the doublets)

Table II. Neutral Sulphite Semichemical Pulping Data

Cook → / Wood →	2 Maple	9 Maple	11 Maple	13 Maple	14 Maple	15 Maple	17 Birch	19 Birch	21 Birch	22 Birch	24 Birch	25 Birch	26 Birch	27 Birch	28 Birch
Sodium sulphite, %	20.0	20.0	20.0	20.0	16.0	16.0	20.0	20.0	20.0	16.0	20.0	16.0	24.0	24.0	24.0
Sodium bicarbonate, %	6.7	6.7	6.7	6.7	5.35	5.35	6.7	6.7	6.7	5.35	6.7	5.35	8.0	8.0	8.0
Water ratio (moisture-free basis), ml./g.	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
White liquor pH	8.7	8.7	8.7	8.7	8.2	8.2	8.7	8.7	8.7	8.2	8.2	8.5	8.1	8.0	8.0
Max. temp., °C.	170	170	170	170	170	170	170	170	170	170	170	170	170	170	180
Time to max. temp., min.	60	60	60	60	120	120	120	120	120	120	120	120	120	120	120
Time at max. temp., min.	180	210	180	150	105	105	105	90	90	90	210	90	210	210	210
Time of final relief, min.	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Bauer refining (1st pass)															
Clearance, in.	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.050	0.050	0.050	0.050	0.050	0.050	0.003
Feed rate	6	7	7	6	7	7	5	4	7	7	7	7	7	7	7
Final consistency (est.), %	8.0+	8.0+	8.0+	8.0+	8.0+	8.0+	8.0	8.0	8.0	8.0	6.0	8.0	8.0	8.0	6.0
Load, amp.	350	300	350	500	450	450	600	450	250	230	220	250	220	260	300
Bauer refining (2nd pass)															
Clearance, in.	..	..	..	..	..	..	..	..	0.002	0.002	0.002	0.002	0.002	0.002	..
Feed rate	..	..	..	..	..	..	..	..	7	7	7	7	7	7	7
Final consistency (est.), %	..	..	..	..	..	..	..	..	6.0	6.0	6.0	8.0	6.0	6.0	
Load, amp.	..	..	..	..	..	..	..	..	350	300	320	330	280	210	..
Unscreened yield, %	61.2[a]	66.0	64.7	64.4	68.9	70.2	73.3	70.4[b]	72.9	74.5	69.9	74.7	69.0	70.0	59.8
Screened yield, %	60.9	62.7	63.4	62.5	66.4	68.5	73.2	70.4	70.9	74.2	68.9	73.4	66.8	69.9	..
Screenings, %	0.5	4.9	2.0	3.1	3.6	2.4	0.28[c]	0.07	2.86	0.45	1.48	1.88	3.29	0.10	..
Black liquor data															
pH	8.8	8.6	8.8	8.7	8.2	8.2	..	..	7.8	7.1	8.7	7.3	8.7	8.4	..
Apparent sulphite (as Na_2SO_3), g./l.	6.7	9.6	11.1	5.4	9.0	10.0	26.0	27.8	27.7	14.9	16.8	17.6	24.6	25.9	..

[a] The yield figures for this cook are somewhat low because of losses sustained in Bauer treatment. [b] The reported yield is probably low as considerable fines made and lost. [c] The screenings from this cook were Bauered at 0.00 clearance, feed rate 5, load 450 amp., and rescreened.

Table III. Comparison of Kraft and Neutral Sulphite Semichemical Pulps

Cook → / *Wood* → / *Process* →	*1 and 3 Maple Kraft*	*2 and 11 Maple NSSC*	*8 and 12 Maple Kraft*	*14 and 15 Maple NSSC*	*18 and 20 Birch Kraft*	*22 and 25 Birch NSSC*	*26 and 27 Birch NSSC*
Active alkali (as NaOH), %	23.9	..	22.0	..	22.5	..	..
Sodium sulphite, %	..	20.0	..	16.0	..	16.0	24.0
Sodium bicarbonate, %	..	6.7	..	5.35	..	5.35	8.0
Av. total cooking time, min.	210	255	280	240	360	225	345
Av. permanganate no.	9.5	..	12.0	..	11.0	..	..
Av. unscreened yield, %	47.9	64.7	50.3	69.5	52.3	74.6	69.5
Av. screened yield, %	47.5	63.4	48.5	67.5	52.2	73.8	68.4
Properties of unbleached pulp at 700 ml. Schopper-Riegler freeness							
Time to freeness, min.	23.5	14	24	16.5	25	15	14.5
Bursting strength, pt./100 lb.	104	87	112	73	124	96	104
Tear factor	1.02	0.97	1.09	0.85	1.38	1.14	1.10
Dry tensile strength, lb./in.	26.3	22.4	30.4	21.2	31.2	27.6	27.3
Av. chlorine applied to obtain 80% brightness, %	3.20	14.0	3.40	17.95	7.60	19.50	13.70
Av. chlorine consumed to obtain 80% brightness, %	2.63	13.85	2.90	17.70	5.08	18.97	13.19
Total yield after bleaching (moisture-free wood basis), %	45.5	52.3	46.3	52.4	50.0	59.4	57.4
Properties of bleached pulp at 700 ml. Schopper-Riegler freeness							
Time to freeness, min.	23.5	8.5	28.5	7.5	22	2	2
Bursting strength, pt./100 lb.	87	103	103	114	116	131	113
Tear factor	1.00	1.18	1.13	1.22	1.06	1.17	1.37
Dry tensile strength, lb./in.	25.0	28.6	27.8	28.0	29.7	32.9	28.2
Opacity, %	76.5	78.0	73.5	66.0	66.0	53.5	58.0
Apparent density	13.7	13.1	13.7	13.1	13.7	14.3	12.6

EVALUATION OF PULPS

Pulp evaluations on both bleached and unbleached pulps were made in a 1.5-lb. Valley beater using TAPPI methods T 200 m-45 and T 220 m-46. The handsheets were tested for basis weight, caliper, bursting strength, tearing strength, dry tensile strength, and opacity on the bleached pulps. Summary data from the beater runs are given in Table III. Some of the pulping, bleaching, and pulp quality data are shown in Fig. 1.

DISCUSSION AND CONCLUSIONS

Pulping

There was nothing unusual in the kraft pulpings. The objective of a pulp with about 50% screened yield and an 8% chlorine demand for 80% G.E. brightness were realized for both maple and birch using quite normal conditions. From the data it is concluded that the birch was a little more difficult to pulp than the maple. The objective in the semichemical pulpings was unbleached yield levels of about 60 and 70%. In the case of the maple semichemical it was concluded after the first four cooks that 60% yield would be obtainable, if at all, only with unreasonably drastic conditions and hence it was concluded that 65% was a reasonable lower yield limit. The 70% yield level was reached fairly easily but the pulp was quite brash. This may have been due to the conditions; however, regardless of pulping conditions it is concluded that 70% is an upper yield level for maple semichemical from which to attempt to produce a bleached pulp. It proved somewhat more difficult to produce birch semichemical below even 70% yield, so yield levels of 70 and 75% were ultimately accepted. To decrease the yield from 75 to 70% took about a third more of both chemical and time. A very drastic cook (no. 28) using 180°C. and 24% sulphite did give a 60% birch semichemical yield. From all the semichemical cooks it is concluded that unbleached yields below 65% are unreasonable for either maple or birch. This finding is in agreement with similar conclusions for several other North American hardwoods. Further, it appeared that careful consideration must be given to obtaining good penetration in maple or birch neutral sulphite semichemical pulpings, particularly if the pulps are to be bleached.

Bleaching

The kraft pulps bleached fairly easily in the three stages used, although the birch kraft required considerable chlorine. The birch semichemical bleached reasonably well in the three stages, but the maple semichemical was relatively more difficult. Both the bleached semichemicals contained an excessive amount of colored shives. It was concluded that these shives reflected some nonuniformity in pulping, which prob-

Table IV. Summary of Concluding Bleaching Data

Cooks	*Permanganate no.*	*Type*	*1st stage chlorination* — % Chlorine: App.	Res.	Time, min.	*3rd stage hypochlorite* — % Chlorine: App.	Res.	*Total % chlorine*: App.	Con.	*Yield, % on wood*: Unbleached	+ 2nd	+ 3rd	*Brightness, G.E.*
1 and 3	9.5	M-K	2.1	0	205	1.1	0.6	3.2	2.6	47.5	46.1	45.5	79.7
8 and 12	12.0	M-K	2.2	0	35	1.2	0.5	3.4	2.9	48.5	47.0	46.3	78.3
18 and 20	11.0	B-K	6.5	2.2	45	1.1	0.2	7.6	5.2	52.2	50.4	50.0	79.0
2 and 11	..	M-NSSC	13.0	0	90	1.0	0.2	14.0	13.8	64.7	53.3	52.3	82.0
14 and 15	..	M-NSSC	16.7	0	135	1.3	0.2	18.0	17.8	69.5	53.2	52.4	81.0
22 and 25	..	B-NSSC	18.0	0.1	45	1.5	0.4	19.5	19.0	74.6	59.4	59.4	78.7
26 and 27	..	B-NSSC	12.5	0.1	45	1.2	0.2	13.7	13.4	69.5	57.7	57.4	79.9

Fixed conditions: chlorination, 3% moisture-free, 20–23°C., cold water wash; caustic extraction, 12% moisture-free, 50°C., 60 min., 3.0% NaOH, cold water wash; calcium hypochlorite, 5% moisture-free, 28°C., 240 min., cold water wash, pH maintained above 8 with NaOH.
Note: All the bleached krafts were shive-free, but all the bleached semichemicals contained many colored shives

ably could be overcome with longer, less drastic cooks, and additional stages in the bleaching sequence such as an additional chlorination with a caustic wash between chlorinations before the caustic extraction. It appears difficult if not impossible to produce an acceptable bleached (80% G.E. brightness) maple or birch semichemical with the three stages and conditions used.

Physical Properties of the Pulps

In general, the birch pulps were stronger than the maple pulps, but when bleached they had lower opacity. This opacity difference was pronounced and probably very significant in the kraft pulps. In the case of the bleached semichemicals the lower birch opacity may have been largely due to the higher birch yield, which presumably reflects higher residual hemicelluloses.

On a process basis, the unbleached krafts were stronger than the unbleached semichemicals, but bleaching so raised the semichemical strengths that they became equal to or even higher than the unbleached krafts.

The semichemical pulps beat very rapidly, particularly after bleaching; whereas all the krafts were resistant to beating. The krafts gave much softer sheets than the somewhat hard, dense semichemical sheets.

From these experiments it would seem that bleached maple and birch pulps suitable for short-fiber furnishes can be produced from either kraft or neutral sulphite semichemical pulps though any choice of process may be governed by desired pulp properties as well as relative pulping and bleaching costs.

LITERATURE CITED

1. Browning, B. L., *Tappi* 32, No. 9: 418–419 (1949).

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Semichemical Pulping of Southern Red Oak

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High-yield pulps suitable for corrugating medium have been prepared from southern red oak (*Quercus rubra*) by the semikraft and the neutral sodium sulphite processes. A single cold caustic cook was made. The semikraft cooks were made at maximum temperatures of 150, 160, and 170° C. with a constant total cooking time of 150 min. The neutral sulphite cooks were made at 160, 168, and 176°C. and 270 min. total time. Chemical dosage was varied at each temperature level. Within these ranges of pulping conditions, the yields from the semikraft cooks were not greatly affected by maximum cooking temperature. Yield decreased some 4% when the maximum temperature was raised from 150 to 170°C. The yields of these cooks were, however, greatly affected by changes in chemical dosage. When the active alkali was increased from 6 to 12%, yield decreased from 80 down to 65%. In general, the opposite effects appeared in the neutral sulphite cooks. Here, yields decreased about 8% when the maximum temperature was raised from 160 to 176°C., but increasing the sodium sulphite dosage from 6 up to 18% decreased the yield only some 4%. Semikraft handsheet flat-crush strength improved with decreasing yield (from about 26 p.s.i. at 80% yield to 34 p.s.i. at 65% yield), but was not greatly influenced by maximum temperature at a given yield. Neutral sulphite flat-crush strengths indicated the same trends but the relationships were not as well defined. The neutral sulphite pulps were stronger and lighter colored than the semikraft pulps. The cold caustic pulp was very weak but light colored. Both the neutral sulphite and the semikraft oak pulps had lower flat-crush than a typical corrugating medium neutral sulphite pulp from aspen.

The present and increasing supply of hardwoods in the southern United States contrasted with a diminishing supply of pine stresses the need for greater utilization of the hardwoods. This will conserve the pine for those grades where long-fibered pulps are most needed and at the same time increase the potential supply of pine by freeing the forests from the pine smothering hardwoods. Expansion of hardwood consumption in corrugating medium seems logical. This should be aided by an array of pulping and related pulp strength data from which process conditions for optimum quality and cost levels may be inferred. Such was the purpose of these experiments in which southern red oak was pulped by the semikraft, neutral sodium sulphite, and cold caustic (*1*) process.

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RAW MATERIALS

The incoming sample was 52 pulpwood sticks of typical southern red oak. These were fresh Spring cut and had been drum barked at the mill. About 10 to 15% of the original bark had not been removed in the barking drum and was not subsequently removed before chipping. The wood had a moisture content of 39.2% (oven-dry). Kraft cooking liquors were made from technical grade sodium hydroxide and sodium sulphide, and the neutral sulphite liquors from technical grade sodium sulphite and c.p. sodium carbonate. No spent liquors were included in any digester charge.

EXPERIMENTAL PROCEDURES

The pulpwood was chipped in a 36-in. two-knife chipper set to deliver a nominal $^5/_8$-in. chip. The chips were not screened but large knots and slivers were manually sorted out and discarded.

Pulping was done in a manually controlled 44-liter stainless steel digester. The cooking liquor was circulated through an external heat exchanger at about 15 liters per min. The chips were placed in a close-fitting stainless steel basket within the digester, because partially softened chips are difficult to blow or remove from the digester at the end of the cook. When 100°C. was reached, the digester pressure was momentarily relieved to 0 p.s.i. At the end of the cook, digester pressure was relieved to atmospheric over a 15-min.

Table I. Semikraft Pulping of Southern Red Oak

	Cook 1	2	3	4	5	6	7	8	9	10	21
Active alkali (as NaOH), %	7.0	10.0	13.0	10.0	11.0	6.0	7.0	13.0	12.0	5.0	9.5
Maximum temperature, °C.	170	160	150	170	150	160	150	160	170	170	150
Yield (moisture-free basis), %	75.9	72.9	68.4	71.0	71.0	79.3	80.4	65.0	66.5	78.2	76.2
Black liquor pH	8.1	9.5	11+	..	10.1	7.8	8.7	10.5	9.8	5.6	9.6
Bauer defibering data											
Feed rate	7	7	7	7	7	7	7	7	7	7	7
Load, amp.	..	400	550	550	520	600	600	300	280	500	500

Constant conditions: water ratio (moisture-free basis), 4 ml./g.; sulphidity, 25.0%; time to maximum temperature, 60 min.; time at maximum temperature, 90 min.; time of final relief, 15 min.; Bauer plates, B-957; Bauer plate clearance, 0.008 in.; Bauer consistency (approx., moisture-free basis), 8%.

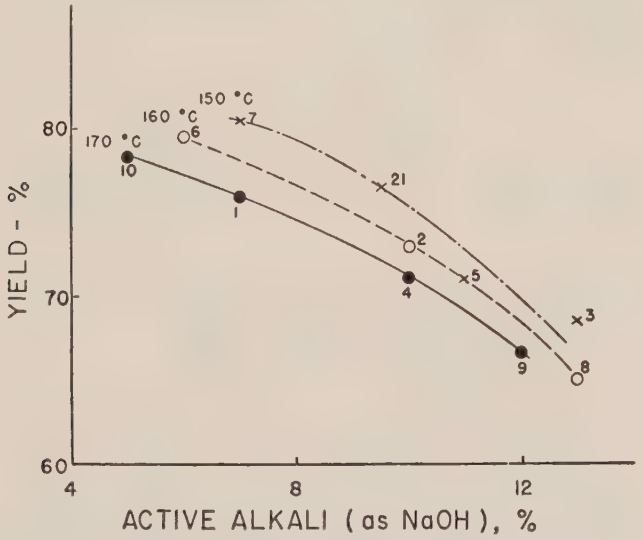

Fig. 1. Per cent moisture-free yield versus per cent active alkali and maximum temperature for semi-kraft pulps

period, the cover removed, and the basket of chips lifted out. The partially cooked chips were immediately defibered in a commercial installation of a 36-in. Bauer pulper equipped with B-957 plates, set at 0.008-in. clearance. The consistency of the defibered material was about 8% moisture-free. The defibered pulp was washed with warm water on a muslin-covered washbox, and then dewatered in a centrifuge. The pulp cake was disintegrated in a laboratory pulp breaker and sampled for moisture content. The pulps were packed in pliofilm bags and stored in a room maintained at 40°F. while waiting evaluation.

The cold caustic soak treatment was applied to the chips in the same digester, but without heat or pressure. The soaked chips were processed in the same manner as the cooked chips.

PULP EVALUATION

Selected pulps were evaluated by forming them into hand sheets of corrugating medium weight and testing these sheets. The pulps were reduced to 450-ml. Canadian Standard freeness in a 1.5-lb. Valley beater using a fixed clearance (nominally zero) between roll and bedplate rather than a weight on the bedplate lever arm. The sheets were made on a 10 by 12-in. sheet-mold, pressed for 5 min. at 125 p.s.i. gage pressure, and dried with an accompanying blotter on a steam-heated drier maintained at 15 p.s.i. pressure. The sheets were not calendered. Basis weight (on a lb./1000 sq. ft. basis), caliper, apparent density, bursting and tearing strengths, ring compression, and single-flute flat-crush resistance (*2*) were determined on each set of sheets.

Table I gives the semikraft pulping data, and Tables II and III give similar data for the neutral sulphite and cold caustic cooks. Figures 1 and 2 are plots of per cent yield against chemical dosage for the semikraft and neutral sulphite cooks, respectively. Tables IV and V give the physical properties of corrugating medium handsheets from the several pulps. In Fig. 3, yield is plotted against single-flute flat-crush for both the semikraft and neutral sulphite pulps. Figure 4 compares

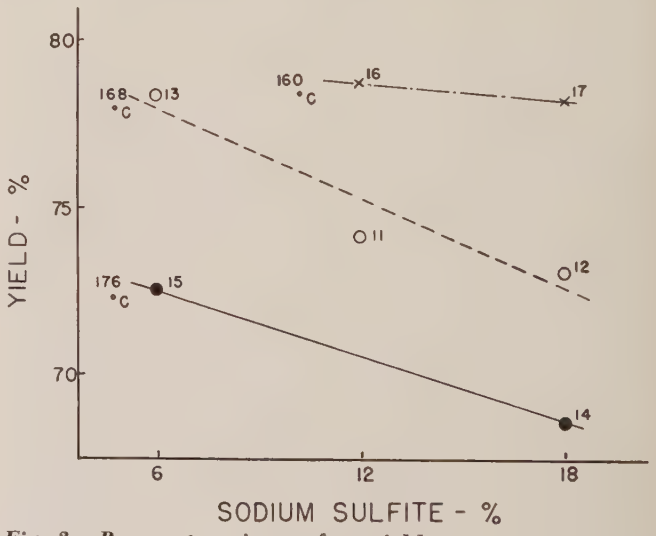

Fig. 2. Per cent moisture-free yield versus per cent sodium sulphite and maximum temperature for neutral sulphite pulps

Table II. Neutral Sulphite Semichemical Pulping of Southern Red Oak

	Cook 11	12	13	14	15	16	17
Sodium sulphite (as Na_2SO_3), %	12.0	18.0	6.0	18.0	6.0	12.0	18.0
Sodium carbonate (as Na_2CO_3), %	5.5	6.0	5.0	6.0	5.0	5.5	6.0
Maximum temperature, °C.	168	168	168	176	176	160	160
Yield, %	74.1	73.0	78.3	68.5	72.5	78.5	77.6
Black liquor pH	9.1	8.8	8.0	9.1	6.3	8.2	8.8
Bauer refining data							
Feed rate	7	7	7	7	7	7	7
Load, amp.	560	330	500	300	450	400	450

Constant conditions: water ratio (moisture-free basis), 4 ml./g.; time to maximum temperature, 180 min.; time at maximum temperature, 90 min.; time of final relief, 15 min., Bauer plates, B-957, Bauer plate clearance, 0.008 in.; Bauer consistency (approx., moisture-free basis), 8%.

Table III. Cold Caustic Soak Treatment of Southern Red Oak

Cook	19
Sodium hydroxide (as NaOH), %	12.5
Water ratio (moisture-free wood basis), ml./g.	4.72
Soaking temperature, °C.	28
Soaking time, min.	120
Yield, %	88.9

Bauer defibering data: plates, B-957; plate clearance, 0.008 in.; consistency (approx., moisture-free basis), 6.0%; feed rate, 5; load, 420 amp.

oak semikraft and neutral sulphite with aspen neutral sulphite.

DISCUSSION

In the series of semikraft cooks the aim was to obtain yields of about 68, 75, and 80% at each of the maximum temperatures of 150, 160, and 170°C., using the same time schedule for all cooks but varying the amount of chemical from cook to cook. There were no difficulties in doing this, as yield was quite predictably dependent on chemical. With neutral sulphite pulping, however, it was soon found that changes in yield were not nearly as easily achieved. Consequently, to remain within the limits of reasonable commercial pulping conditions, a narrower range of yields was necessarily accepted in the neutral sulphite cooks. This difference in yield change sensitivity between the semikraft and neutral sulphite processes probably follows quite logically from the known facts that the semikraft liquor dissolves

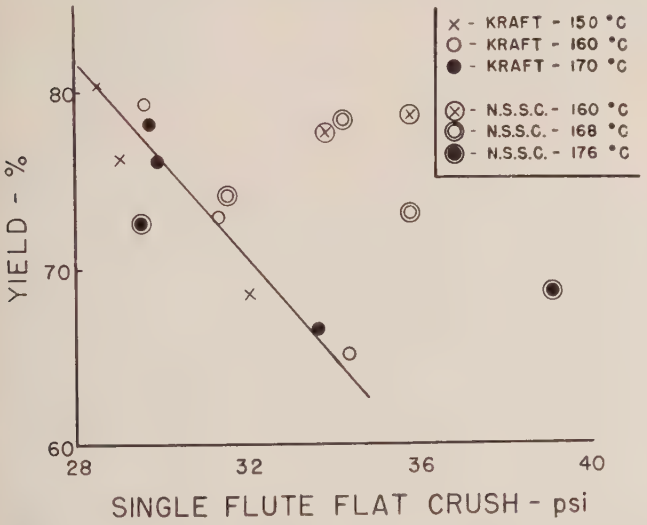

Fig. 3. Per cent moisture-free yield versus handsheet single-flute flat-crush strength

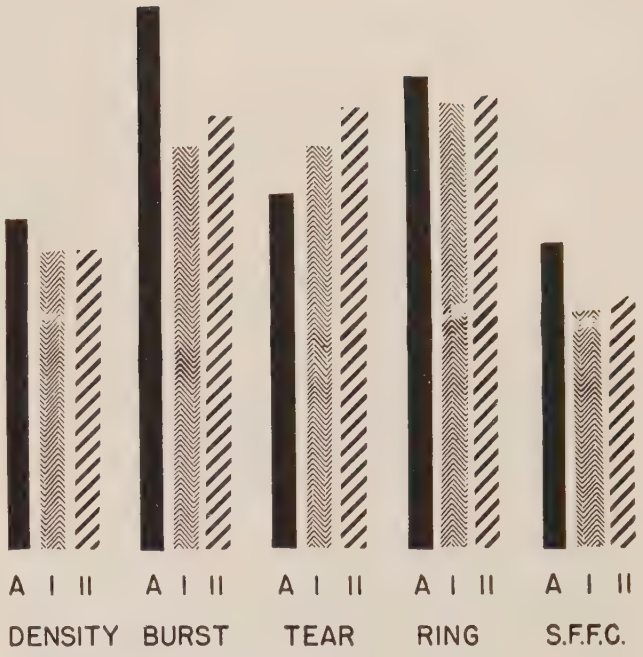

Fig. 4. Comparison of pulp properties of aspen neutral sulphite semichemical (A), oak semi-kraft (I), and oak neutral sulphite semichemical (II), each at 75% moisture-free yield

both carbohydrates and lignin from the wood at about equal rates and thus there is a wide range of possible yields; whereas neutral sulphite liquors dissolve lignin, but much less carbohydrates. The spent liquor from two of the neutral sulphite cooks (nos. 13 and 15) had a lower pH than considered safe for best pulp quality and color. Cook 15 was particularly adversely affected. These and other neutral sulphite cooking experiments suggest that sufficient chemical (sulphite and/or carbonate) should be charged at the start of the cook so that the final pH is not below about 8 to 8.5, if maximum retention of carbohydrates and good pulp color are to be achieved. Both of these cooks were considerably darker colored than the other neutral sulphite cooks.

Before examining the particular data obtained from evaluating these experimental pulps, some thought may usefully be given to the general problem of evaluating this class of pulps.

It is considered that there is need for development and subsequent standardization of a better technique for predicting the properties obtainable in corrugating medium from high-yield wood pulps. Until other meth-

Table IV. Physical Properties of Corrugating Medium Handsheets from Southern Red Oak Semikraft Pulps

	Cook 1	2	3	6	7	8	9	10	21
Yield (moisture-free basis), %	75.9	72.9	68.4	79.3	80.4	65.0	66.5	78.2	76.2
Basis weight (12 × 12—1000), lb.	27.4	27.5	26.8	27.0	27.3	27.4	27.6	27.5	27.0
Caliper, pt.	14.1	12.9	14.0	15.0	15.0	11.4	12.4	14.6	15.6
Apparent density	1.9	2.1	1.9	1.8	1.8	2.4	2.2	1.9	1.7
Bursting strength, p.s.i.g.	51	59	54	45 (6)	44 (8)	69	68	46 (2)	46
Ring compression, lb.	55.3	46.0	43.4	43.9	49.8	60.7	57.1	44.4	39.2
Elmendorf tear, g./sheet	101	109	114	85	88	117	128	91	101 (1)
Single-flute flat-crush, p.s.i.	29.9	31.3	32.0	29.6	28.5	34.3	33.6	29.7	29.0
Brightness, G.E., %	8.6	10.1	13.0	12.6	14.9	12.4	10.6	10.5	12.9

Notes: The handsheets were preconditioned for at least 24 hr. at no higher than 35% R.H., 73°F., and conditioned for 48 hr. at 50% R.H., 73°F., prior to testing.

Apparent density: basis weight/caliper in thousands of an inch.

Bursting strength: A clamping pressure of 100 p.s.i. was used. The figure in parentheses after the average bursting strength value records the number of specimens which gave test values lower than the diaphragm pressure. In all cases this number included the specimen which gave the minimum reading. A total of 10 specimens was tested per sample.

Ring compression: The modified Riehle compression tester was used. The size of specimen was 6 by 0.5 in.

Tear: The figure in parentheses after the average tear value indicates the number of specimens out of a group of 10 in which the tear deviated more than 3/8 in. from the projection of the initial slit.

Table V. Physical Properties of Corrugating Medium Handsheets from Southern Red Oak Neutral Sulphite Pulp and Cold Caustic Pulp

	Cook							
	11	12	13	14	15	16	17	19[a]
Yield (moisture-free basis), %	74.1	73.0	78.3	68.5	72.5	78.5	77.6	88.9
Basis weight (12 × 12—500), lb.	27.3	27.8	28.4	28.0	27.2	27.2	27.5	28.1
Caliper, pt.	14.2	13.1	13.8	11.7	14.4	13.4	14.5	18.4
Apparent density	1.9	2.1	2.1	2.4	1.9	2.0	1.9	1.5
Bursting strength, p.s.i.g.	55	64	53	77	50	61	56	18(10)
Ring compression, lb.	57.4	61.4	55.6	64.1	49.2	52.1	49.6	26
Elmendorf tear, g./sheet	111(1)	111(2)	105(1)	125	106	94	98	42(2)
Single-flute flat-crush, p.s.i.	31.5	35.8	34.2	39.1	29.5	35.8	33.8	14.6
Brightness, G.E., %	29.7	32.6	18.7	31.5	15.1	33.5	34.8	37.4

[a] Cold caustic cook.

Notes: The hand sheets were preconditioned for at least 24 hr. at no higher than 35% R.H., 73°F., and conditioned for 48 hr. at 50% R.H., 73°F., prior to testing.

Apparent density: basis weight/caliper in thousandths of an inch.

Bursting strength: A clamping pressure of 100 p.s.i. was used. The figure in parentheses after the average burst strength value records the number of specimens which gave test values lower than the diaphragm pressure. In all cases this number included the specimen which gave the minimum reading. A total of 10 specimens was tested per sample.

Ring compression: The modified Riehle compression tester was used. The size of specimen was 6 by 0.5 in.

Tear: The figure in parentheses after the average tear value indicates the number of specimens, out of a group of 10, in which the tear deviated more than 3/8 in. from the projection of the initial slit.

ods are developed and shown to be more useful, such predictions will probably continue to involve a sequence of defibering the softened chips to a suitable fibrous state, then lightly refining these fibers and finally forming handsheets and testing these sheets for strength. The development of the single fluter by McKee (*2*) and the accumulating evidence of its usefulness, emphasize the need for an acceptable defibering-refining step. The standard TAPPI methods, while suitable for typical papermaking pulps, are not considered useful in evaluating high-yield wood pulps for corrugating medium. In particular, the standard beating procedure tends to produce excessive "hydration" in these high-yield pulps before sufficient cutting and separation of the fibers is achieved. However, a light refining of the defibered chips in the standard TAPPI beater operated with the bedplate clamped at zero clearance can avoid excessive "hydration" and achieve a fiber length distribution that is very similar to that from high-yield wood pulps which have been mill refined for corrugating medium. This clamped bedplate technique is therefore recommended for refining of defibered softened chips, and the opportunity to discuss results from it would be welcomed. While the full-sized commercial disk refiner used in these laboratories gives acceptable defibering results, there remains need of a good purely laboratory technique for the initial defibering of the softened chips. To this end, a technique using a stirrer is being studied, and the examination of a laboratory-sized disk refiner is planned.

Table VI. Physical Properties of Corrugating Medium Handsheets from Southern Red Oak Cold Caustic Soak Pulp

Cook	19
Basis weight (12 × 12—1000), lb.	28.1
Caliper, pt.	18.4
Apparent density	1.5
Bursting strength, p.s.i.g.	18(10)
Ring compression, lb.	26.0
Elmendorf tear, g./sheet	42(2)
Single-flute flat-crush, p.s.i.	14.6

Notes: The handsheets were preconditioned for at least 24 hr. at no higher than 35% R.H., 73°F., and conditioned for 48 hr. at 50% R.H., 73°F., prior to testing.

Apparent density: basis weight/caliper in thousandths of an inch.

Bursting strength: A clamping pressure of 100 p.s.i. was used. The figure in parentheses after the average bursting strength value records the number of specimens which gave test values lower than the diaphragm pressure. In all cases this number included the specimen which gave the minimum reading. A total of 10 specimens was tested per sample.

Ring compression: The modified Riehle compression tester was used. The size of specimen was 6 by 0.5 in.

Tear: The figure in parentheses after the average tear value indicates the number of specimens, out of a group of 10, in which the tear deviated more than 3/8 in. from the projection of the initial slit.

High flat-crush resistance is probably the most desirable and important property in a corrugating medium pulp. In this property the pulps described in these experiments exhibit some interesting relationships. For example, as shown in Fig. 3, the semikraft cooks have a very good correlation between single-fluter flat-crush and yield. This relationship is apparently independent of how the yield was obtained, and in particular is independent of maximum temperature. From Fig. 1 it is apparent that yield is very dependent on active alkali. Thus it would seem that for a given length of cook the flat-crush resistance of semikraft pulps is almost solely directly dependent on the amount of chemical used. The neutral sulphite pulps exhibit only a slight tendency toward a correlation between yield and flat-crush resistance. From these limited data it is tentatively concluded that there are other factors in pulping besides yield which determine the flat-crush resistance of neutral sulphite pulps. The low strength of cook 15 suggests that final liquor pH is one of these. Despite the apparent sensitivity of the flat-crush resistance of neutral sulphite pulps to cooking conditions, it is apparent that they are significantly stronger than semikraft pulps over the whole range of conditions examined.

The semikraft pulps were all considerably darker than the neutral sulphite pulps, though the neutral sulphite cooks which ended on or near the acid side were quite dark colored.

In comparing these high-yield southern red oak pulps with similar typical aspen pulps (Fig. 4) it is apparent that their flat-crush resistance is relatively low and therefore they would require the admixing of some assisting fiber if best quality corrugating medium were to be made from them. If a choice of pulping processes is possible, it appears that neutral sulphite is preferable to semikraft for a given yield because it produces stronger, brighter pulps.

LITERATURE CITED

1. Brown, K. J., and McGovern, J. N., *Tappi* 33, No. 8: 364–368 (Aug., 1950).
2. McKee, Robert C., *Fibre Containers* 36, No. 9: 40, 45–46, 48, 53–54 (Sept., 1951).

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Esters of Distilled and Acid Refined Tall Oil as Varnish Vehicles

P. D. PATRICK, JR., M. G. BESTUL, and ROBERT W. GRESSANG

Glycerol esters of three representative acid-refined and four distilled tall oils were prepared, made into varnishes, and evaluated for film properties. Neither type of tall oil gave ester varnishes which dried tack-free in 18 hr. The acid-refined tall oil esters, because of their higher rosin acids content, gave harder films. Water and alkali resistance of both types were moderate to poor and roughly comparable. Alkyd resins (24% phthalic anhydride) modified with the distilled tall oils gave varnishes of 10 to 11 color Gardner and Z-6 viscosity at 100% solids. Alkyd varnish films dried tack-free in 17 to 18 hr., had good hardness, flexibility, and moderate to poor alkali and water resistance. Glycerol ester varnishes of a distilled and an acid refined tall oil were blended with a commercial 20-gal. tung oil modified phenolic resin varnish in varying proportions up to 70% tall oil ester by weight of the total varnish solids. Film evaluation showed that up to 50% glycerol ester of either type tall oil can be blended with the commercial varnish to obtain a vehicle which dries tack-free overnight, has good flexibility, and which is suited for use where water and alkali exposure are not critical.

One of the largest volume uses of tall oil today is in the paint and varnish field. Evidence of its increasing acceptance is the fact that some 2 million lb. of tall oil were used by the paint and varnish industry in 1943 and in 1951 this figure had risen to almost 28 million lb. (*1*). According to Bureau of Census figures, total consumption of tall oil for all uses except refining was about 187 million lb. in 1951. It is apparent, then, that 15%, or roughly one sixth, of all tall oil used in 1951 went into manufacture of paints and varnishes.

Of a total use in 1951 of 85 million lb. of refined and distilled tall oil, 27.7 million lb. or roughly 32% went into paints and varnishes. Further emphasis of the importance of tall oil in this field is the fact that Bureau of Census figures show that in 1951 only linseed, soybean, and tung oils were used in greater volume than tall oil in the paint industry (*1*).

Since tall oil is a mixture of free acids rather than an ester it is not strictly analogous to common vegetable drying oils such as linseed or soybean oil. It must be modified to make it suitable for drying oil applications. These modifications can be accomplished by (1) blowing, (2) liming, (3) esterification with polyhydric alcohols, (4) formation of tall oil modified alkyd resins, or (5) treatment with an unsaturated monomeric hydrocarbon such as styrene or cyclopentadiene. It is proposed to discuss here only tall oils modified by esterification and by incorporation into alkyd resins.

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COMPARISON OF VARNISHES MADE FROM ESTERS OF ACID REFINED AND DISTILLED TALL OILS

The two methods most widely used commercially for refining tall oil are acid refining and distillation. The products of these two processes are alike in that they have greatly improved color and odor over the original whole tall oil. They differ principally in the amount and form of rosin acids, and in the fatty acids and unsaponifiable contents. Typical analyses of each are as follows:

	Distilled tall oil	*Acid refined tall oil*
Acid value	188	160
Rosin acids, %	32	42
Fatty acids, %	66	49
Unsaponifiables, %	2	9
Viscosity, Gardner-Holdt	C	U-V
Color, Gardner	9	12

One objective of refining is to achieve a stable product in which no separation of rosin and fatty acids occurs. In distillation this is accomplished by partial removal of the rosin acids until the remainder no longer precipitate from (or crystallize out of) the fatty acids solution; in acid refining stability is accomplished by polymerizing the rosin acids to a noncrystallizing form.

Both acid refined and distilled tall oils are used in varnishes. In the present work three commercial acid refined tall oils and four commercial distilled tall oils were esterified with glycerol and made into varnishes.

Table I. Analyses of Tall Oils Used

Tall oil	*Acid No.*	*Rosin acids, %*	*Fatty acids, %*	*Unsaponifiables, %*	*Viscosity, Gardner-Holdt*	*Color, Gardner*
			Acid Refined			
A	166	42.5	49.3	8.2	U-V	13
B	160	42.0	49.0	9.0	U-V	12
C	164	48.0	44.8	7.2	Z-1 to Z-2	13
			Distilled			
D	183	30.0	63.5	6.5	D	10
E	182	28.0	67.1	4.9	C	5
F	188	32.0	66.3	1.7	C	9
G	189	30.0	67.2	2.8	B-C	9

Films of the varnishes were laid down and evaluated for drying time, hardness, flexibility, and water and alkali resistance. Analyses of the various tall oils used are given in Table I. Analytical procedures used were standard ASTM methods (*2*).

PREPARATION OF ESTERS AND VARNISHES

In preparing each ester, a 400-gram sample of tall oil

was weighed into a 1000-ml. three-necked flask fitted with an inert-gas connection, thermometer, agitator, and heating mantle. An amount of glycerol 2% in excess of that calculated to give a zero acid number was added. Gas flow and agitation were started and the temperature was raised to 230°C. (445°F.) and held for 1 hr. The temperature was increased to 280°C. (536°F.) and held for an acid number of 8 to 12.

Varnishes were prepared by diluting with an amount of mineral spirits sufficient to give a Gardner-Holdt viscosity of E-H. Naphthenate driers were added to provide 0.5% lead, 0.08% cobalt, and 0.02% manganese based on varnish nonvolatile.

Properties of the esters and their respective varnishes are given in Table II.

It is apparent from the data in Table II that the acid refined tall oil esters were much more viscous than the distilled tall oil esters and that the colors of both types of esters are roughly equivalent to the colors of their respective starting materials. The higher rosin acid contents of the acid refined oils result in the shorter oil length varnishes as indicated in Table II.

Table II. Properties of Tall Oil Esters and Their Varnishes

Ester made from tall oil	Ester properties			Varnish properties		
	Acid No.	Viscosity, Gardner-Holdt	Color, Gardner	Solids, %	Viscosity, Gardner-Holdt	Oil length, gal.[a]
			Acid Refined			
A	11	Z-4	12.5	82	F	17
B	10	Z-3	12.5	83	H	17
C	10	Z-6	12.5	78	G	14
			Distilled Tall Oil			
D	11	S-T	11.5	92	G	31
E	11	T	7	90	G	32
F	11	T	12	91	G-H	27
G	11	P	10	94	G-H	31

[a] Calculated assuming rosin acid esters as resin and fatty acid esters as oil.

Results of evaluation of the ester varnish films are given in Table III. None of the esters tested dried tack-free in 18 hr. Set-to-touch and dry time showed that the acid refined tall oil ester varnishes were drying at an appreciably faster rate than the distilled tall oil ester varnishes. This is further substantiated by the film hardness measurements made after 2, 7, and 14 days. The influence of rosin acids content on film hardness is indicated by the fact that the ester of acid refined tall oil C, which had the highest rosin acids content, also had the hardest film. Alkali and water resistance measurements showed that the acid refined and distilled tall oil esters were roughly equal in this respect.

ALKYD RESINS MODIFIED WITH DISTILLED TALL OIL

A commonly used method of incorporating tall oil in paint vehicles is tall oil modifications of alkyd resins. In the narrow sense, an alkyd resin can be defined as the reaction product of a dibasic acid and a polyhydric alcohol. This is typified by glycerol phthalate, the reaction product of phthalic acid and glycerol. To make this compound more useful the chemist has reacted it with either drying or nondrying fatty acids, thus making it soluble in common organic solvents and obtaining a film-forming material. The result has been that today an alkyd resin is commonly thought of as consisting of three basic constituents: polyhydric alcohol, dibasic acid, and fatty acid. This offers a wide range of possible combinations which affords resin products of widely different properties.

Table IV. Properties of Distilled Tall Oil Alkyds and Their Varnishes Distilled Tall Oil

Alkyd made from tall oil	Alkyd properties			Varnish properties		
	Acid No.	Viscosity, Gardner-Holdt	Color, Gardner	Solids, %	Viscosity, Gardner-Holdt	Oil length,[a] gal.
D	11	Z-6	11.5	63	G	13
E	11	Z-6	10	67	G	13
G	8	Z-6	10.5	66	G	13

[a] Calculated assuming tall oil fatty acid esters as oil and glycerol phthalate plus tall oil rosin acid esters as resin.

Of particular interest is the fact that the inherent function of alkyd resins permits the use of semidrying or even nondrying fatty acids as one of the three components. Consequently, tall oil acids which are considered to be of the semidrying type and which are often limited in protective coatings applications when used as straight esters, can be employed with good results in alkyd resins.

In the present work three distilled tall oils were used to prepare 24% phthalic glycerol tall oil modified alkyd resins. These alkyds were made into varnishes, as in the case of the aforementioned tall oil esters. The varnish films were laid down and evaluated for drying time, hardness, flexibility, and water and alkali resistance. Data on alkyd properties and on varnish film evaluation results are presented in Tables IV and V, respectively.

Table III. Film Properties of Tall Oil Ester Varnishes

Ester made from tall oil	Drying time, hr.			Hardness, Sward			Flexibility[c]	Alkali resistance, 1% NaOH[a]	H_2O resistance	
	Set to touch	Dry	Tack-free	After 2 days	After 7 days	After 14 days			Cold, 18 hr.[b]	Hot, 15 min.[b]
					Acid Refined					
A	5	13	>18	2	2	4	P	10	5	3
B	13	>18	...	...	4	4	P	10	3	3
C	8	17	>18	2	4	10	F	10	3	5
					Distilled					
D	>18	...	...	...	...	0	P	10	3	3
E	>18	...	...	...	...	0	P	10	3	3
F	>18	...	...	...	...	0	P	10	3	4
G	>18	...	...	...	...	0	P	10	3	3

[a] Time to failure in minutes.
[b] Numeral denotes classification as follows: 1—not visibly affected; 2—whitening disappears within 20 min.; 3—whitening disappears within 1 hr.; 4—whitening disappears within 24 hr.; 5—whitening does not disappear within 24 hr.
[c] P = passed; F = failed.

Table V. Film Properties of Varnishes Made from Distilled Tall Oil Modified Alkyd Resins Distilled

Alkyd made from tall oil	Drying time, hr.			Hardness, Sward			Flexibility	Alkali resistance, 1% NaOH[a]	H_2O resistance	
	Set to touch	Dry	Tack-free	After 2 days	After 7 days	After 14 days			Cold, 18 hr.[b]	Hot, 15 min.[b]
D	4	10	17	10	14	14	P	25	5	4
E	3	5	18	6	10	12	P	20	5	4
G	5	11	18	12	16	16	P	25	5	3

[a] Time to failure in minutes.
[b] Numeral denotes classification as follows: 1—not visibly affected; 2—whitening disappears within 20 min.; 3—whitening disappears within 1 hr.; 4—whitening disappears within 24 hr.; 5—whitening does not disappear within 24 hr.

PREPARATION OF TALL OIL MODIFIED ALKYD RESINS AND VARNISHES

The tall oil modified alkyd resins were prepared using an amount of phthalic anhydride calculated to give a 24% phthalic content. Four hundred grams of tall oil were weighed into a 1000-ml. three-necked flask fitted with a thermometer, inert gas connection, agitator, and heating mantle. The calculated amount of glycerol (for the tall oil and phthalic) was added, agitation and inert gas flow started, and the batch heated to 230°C. (445°F.) and held for 1 hr. The required amount of phthalic anhydride was added and the temperature was maintained at 230°C. for another hour. The temperature was then increased to 275°C. (526°F.) and held for an acid number of 8 to 12.

Varnishes were prepared as in the case of the tall oil esters by diluting with mineral spirits to a Gardner-Holdt viscosity of E-H. Naphthenate driers were added to give 0.5% lead, 0.08% cobalt, and 0.02% manganese based on varnish solids.

Properties of the tall oil modified alkyds and varnishes are given in Table IV.

Examination of data in Table IV shows that the three tall oils used all gave alkyds of about the same color and viscosity. With the exception of tall oil E the colors of the alkyds were roughly the same as the colors of the distilled tall oil esters. As expected, the alkyds were considerably more viscous than their comparable tall oil esters.

Drying tests showed that the distilled tall oil alkyd varnish films all dried in 18 hr. or less. These data are shown in Table V. The films were satisfactory in hardness and flexibility and their alkali resistance was somewhat improved over that of the straight ester varnishes. Water resistance was roughly comparable. These data are useful chiefly in demonstrating the common use of distilled tall oil in alkyds and the superiority of the alkyd varnishes over the straight ester varnishes.

BLENDS OF TALL OIL ESTERS WITH A STANDARD COMMERCIAL VARNISH

A common method of using tall oil in paint vehicles is to blend esterified tall oil with a more rapid-drying standard commercial varnish. In this way the tall oil ester serves as an inexpensive diluent for the more expensive vehicle. It was decided to investigate the effect of increasing amounts of tall oil ester on the film properties of the blends.

The commercial vehicle used was a 20-gal. tung oil modified phenolic resin varnish having a color of 11 to 12 Gardner and a D-G Gardner-Holdt viscosity at 50% solids in mineral spirits. This varnish was obtained from a paint manufacturer.

Glycerol esters of a distilled tall oil and an acid refined tall oil were cold-blended with the tung oil varnish to give blends of 10, 20, 30, 40, 50, and 70% of tall oil ester solids based on the total solids of the blends. Films of each of these blends were laid down and evaluated for drying time, hardness, flexibility, and hot water and alkali resistance.

Colors of the distilled tall oil ester-commercial vehicle blends ranged from 10 to $11^1/_2$ Gardner with increasing amount of tall oil ester. The corresponding viscosities ranged from G to O Gardner-Holdt. Blends of the acid refined ester-commercial vehicle had colors of from $10^1/_2$ to 16 and viscosities of G to N.

Data on the evaluation of the films are given in Table VI.

The dry hard tack-free time for the standard commercial varnish was 15 hr. 30 min. Although the drying time data are slightly erratic, it is apparent that drying time of the blends becomes increasingly longer with

Table VI. Film Properties of Blends of Tall Oil Esters with a Standard Commercial Varnish

Amount of tall oil ester blended with tung oil vehicle, %	Drying time, hr.-min.			Hot water resistance, min. to recover	Failure in 1% NaOH, hr.	Hardness, Sward			Flexibility,[a] after 24 hr.
	Set to touch	Dry	Tack-free			After 24 hr.	After 48 hr.	After 7 days	
Tung oil vehicle	0-36	3-02	15-30	6	337	8	12	28	OK
			Distilled Tall Oil Glycerol Ester Blends						
10	0-46	3-03	16-00	21	337	8	10	20	OK
20	0-20	1-33	Over 18	13	104	4	9	16	OK
30	0-47	2-55	17-34	16	38	6	8	12	OK
40	1-00	2-49	14-53	16	23	4	4	10	OK
50	1-12	6-30	17-33	25	7	4	4	6	OK
70	1-50	12-00	Over 18	25	4	Tacky	Tacky	4	Tacky
			Acid Refined Tall Oil Glycerol Ester Blends						
10	0-52	2-56	15-13	21	231	8	14	22	OK
20	1-04	3-13	16-03	28	289	8	10	24	OK
30	0-44	3-19	16-05	22	158	8	12	20	OK
40	0-36	1-44	16-26	28	64	6	10	18	OK
50	1-19	2-43	16-35	62	27	6	10	16	OK
70	1-51	8-16	Over 18	77	23	4	6	14	Fail

[a] Flexibility measurements were made by bending film applied to 30-gage tin plate over $^1/_8$-in. diam. mandrel.

increasing tall oil ester content. However, only when the tall oil ester content exceeded 50% was the dry hard time in excess of 18 hr.

Water and alkali resistance of the blends declined rapidly with increased tall oil ester content. In the case of the distilled tall oil ester blends, alkali resistance declined to roughly one tenth the value for the tung oil vehicle when the tall oil ester content reached 30%. For the acid refined tall oil ester blends a corresponding point was reached at about 50% ester content.

Film hardness, as measured by the Sward rocker, decreased progressively with increased amounts of tall oil esters in the blends. The sensitivity of the flexibility test (on a 1/8-in. diam. mandrel) was not sufficient to detect differences except in the case of the blend containing 70% acid refined tall oil ester.

Information of this type should be helpful in enabling a paint formulator to determine the maximum amount of tall oil ester that can be blended with a more expensive faster-drying vehicle without exceeding film property limitations. For example, up to about 50% of the glycerol ester of either distilled or acid refined tall oil can be blended with the 20-gal. tung oil modified phenolic resin vehicle to obtain a varnish which dried tack-free overnight, has good flexibility, and is suitable for use where water and alkali resistance are not critical.

Assuming the tung oil vehicle to cost twice as much as the tall oil ester, the 50% blend would result in a saving of about 25% over the cost of the tung vehicle alone. It would be necessary, of course, to study the properties of the blends of the tall oil ester with the particular vehicle to be used before an optimum blend could be determined.

FILM TESTING METHODS

Varnish films were tested by methods commonly used by the paint and varnish industry. Tests used and a description of the methods are as follows:

Drying Time

Varnish films were applied to glass strips using a Film-O-Graph applicator set to give a film thickness of 0.003 in. A Gardner drying time recorder was used to measure set-to-touch, dry time, and dry hard track-free times. Definitions of these terms are as follows:

1. Set-to-touch—time required for a varnish film to reach a stage in drying at which it will not flow.
2. Drying time—time required for a varnish film to reach a stage in drying at which the traveling cogs of the recorder no longer remove varnish from the strip but merely travel over the surface and leave surface indentations.
3. Dry hard tack-free time—time required for a varnish film to reach a stage in drying at which the traveling cogs of the recorder no longer make an impression in the films.

Hot Water Resistance

Films of 0.003 in. thickness were applied using a Bird film applicator to 3 by 5-in. tin plate and allowed to dry (48 hr. for tall oil ester varnishes and 24 hr. for blend varnishes). The plate was submerged in gently boiling water for 15 min. and then removed and its appearance noted. Time for recovery of the film was observed.

Alkali Resistance

Films were applied to a 1 by 6-in. test tube by dipping it into the varnish, inverting it, and allowing it to dry (24 hr. for blend varnishes and 48 hr. for tall oil ester varnishes). The test tube was then placed in a beaker containing a 1% aqueous solution of NaOH. At periodic intervals the tubes were removed, rinsed with cold water, and the film examined. Time to failure of the film was noted.

Flexibility

Varnish films applied to tin plate (as described under "Hot Water Resistance") were tested for flexibility by bending over a 1/8-in. diam. mandrel. If cracking of the film occurred the film was classed as "failed." Results were recorded as "passed" or "failed."

Hardness

Films of 0.003 in. thickness were applied to a glass plate using a Bird film applicator. Film hardness measurements were made with a Sward hardness rocker after 24 hr., 48 hr., and after 7 days. The rocker is calibrated at 25 °C. to make 50 oscillations in 60 + 0.5 sec. on a level polished plate glass surface.

LITERATURE CITED

1. Bureau of Census, U. S. Dept. Commerce, "Facts for Industry," 1951.
2. ASTM, "Standard Methods of Testing Tall Oil," D 803–51.

Received Jan. 18, 1953. Presented at the 38th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 16–19, 1953.

Variable Shear Viscometers for Cellulose Intrinsic Viscosity Determination

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Viscosities of a number of samples of cellulose have been measured in 0.5 *M* cupriethylenediamine using Ubbelohde, modified Wagner-Russell, and Brookfield viscometers. From these data, intrinsic viscosities ([η]) were were calculated using the one-point method proposed by Martin (*Tappi* 34: 363 (1951)), and compared with values obtained by the multipoint procedure at the normally encountered shear rates and also with values obtained at zero shear rate. For solutions having [η] C = 3.0 + 0.5, where C is concentration in grams per 100 ml., it was found that for samples whose [η] = 10 or lower, the solutions are Newtonian and hence the measured values are independent of the rate of shear. For samples having a higher [η], the solutions are shear sensitive. In the range [η] = 10 to 16, [η] may be obtained by the one-point method with moderate accuracy using shear rates in the range 50 to 250 sec.$^{-1}$. Samples having [η] > 16 show marked shear sensitivity, and viscosities should be obtained at as low a shear rate as feasible. Intrinsic viscosities, obtained from such data, will approach the theoretically sound value calculated

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from data at zero rate of shear. It is recommended that viscosities be measured at a maximum shear rate of 50 sec.$^{-1}$. Reliable intrinsic viscosities are obtained from these observed viscosities by the one-point method. A simple rapid rotational viscometer is suggested for control use and a capillary instrument for referee use.

VISCOSITY is one of the most important measurements used to characterize cellulose. Viscosity is correlated with the strength properties of paper such as tear, tensile, burst, and fold. A number of methods for measuring the viscosity of cellulose solutions are in current use. These methods differ in solvent composition and cellulose concentration, and some specify special viscometers. This has led to some confusion and to an inability to compare, directly, the results obtained by the various methods. Since the properties of the final paper which are usually correlated with viscosity are functions of the degree of polymerization (D.P.) of the cellulose, it is obviously desirable that the result of the viscosity measurement should be a simple function of D.P. Such a quantity is the intrinsic viscosity, $[\eta]$.

Let us define η as the viscosity of the cellulose solution, η_0 as that of the solvent, and C as the concentration of cellulose in grams per 100 ml. of solution.

Then

$$\eta/\eta_0 = \eta_{rel} \tag{1}$$

and

$$\eta/\eta_0 - 1 = \eta_{rel} - 1 = \eta_{sp} \tag{2}$$

where η_{rel} and η_{sp} are the relative and specific viscosities, respectively.

The intrinsic viscosity $[\eta]$ is then defined as

$$[\eta] = \lim_{C \to 0} (\eta_{sp}/C) \tag{3}$$

Work with numerous polymer-solvent systems has demonstrated a simple relationship between $[\eta]$ and D.P. It is therefore desirable to report cellulose viscosities as intrinsic viscosities if this can be done without undue cost.

In the past, cellulose intrinsic viscosity has been determined by measuring the viscosity of solutions at several concentrations, calculating η_{sp}/C for each concentration, plotting η_{sp}/C against C, and extrapolating to $C = 0$. This is too long a procedure for control use.

A significant simplification was proposed by Martin (*1*). It has been established that the Martin equation

$$\eta_{sp} = [\eta] C e^{K[\eta]C} \tag{4}$$

holds for cellulose in ACS cuprammonium and 0.5 M cupriethylenediamine and that the constant K' has the same value, 0.30, in both systems. This offers the possibility of determining the intrinsic viscosity of a cellulose sample from a single viscosity measurement and means that the fundamental quantity $[\eta]$ may be as readily determined as any of the arbitrary viscosities currently in use.

A consideration of the Martin equation shows that if the $[\eta]C$ product is held constant, then η_{sp}, η_{rel}, and η (the viscosity of the cellulose solution) will be constant. An analysis of errors in the use of this equation, together with practical viscometric considerations (*1*, *2*), suggests the use of $[\eta]\,C = 3.0 \pm 0.5$. The method is carried out as follows: a solution of cellulose is prepared having a concentration such that $[\eta]C$ should fall in the range given above, and its viscosity is determined. This is divided by the viscosity of the solvent to give η_{rel}. The value of $[\eta]C$ corresponding to this is determined from Tables I or II, and $[\eta]$ is found by dividing this value by the known concentration of the solution. If the solution gives a value of $[\eta]C$ which falls outside the limits given above, a tentative value of $[\eta]$ is determined from Table I. Another solution is prepared having a concentration such that $[\eta]C = 3.0 \pm 0.5$, its viscosity is determined, and $[\eta]$ is found by reference to Table II.

This method has the advantages that all celluloses are measured at the same solution viscosity and, with a given viscometer, the velocity gradient will be the same for all celluloses.

The Cellulose Disperse Viscosity Subcommittee (*2*) reported on this method at the ACS meeting in Atlantic City in September, 1952, and suggested that two types of viscometers be considered: a rapid simple instrument of moderate accuracy for control use and a precise capillary instrument for referee work.

It has long been known (*3*, *4*) that the apparent viscosity of a solution of cellulose of high D.P. will vary as the rate of shear at which it is measured is changed. Such solutions are pseudoplastic, i.e., the apparent viscosity becomes lower as the rate of shear is increased. Conrad (*3*) has suggested that all viscosities be converted to a mean velocity gradient of 500 sec.$^{-1}$, since this value is easily attained in ordinary capillary viscometers. Wilson (*4*) recommends the use of a Wagner-Russell viscometer (*5*) and correction of the results to a shear rate at the wall of 200 sec.$^{-1}$ (calculated for a Newtonian liquid). Martin (*2*), in his subcommittee report, pointed out that if two viscometers were selected for a referee method, they should both operate at the same shear rate. A possible combination was a special Brookfield rotational viscometer for rapid control use, and a modified Wagner-Russell viscometer for referee

Table I. Relation Between Relative Viscosity (η_{rel}) and Intrinsic Viscosity ($[\eta]$) for Values of $[\eta]C = 1.0 - 9.9$
C = concentration in g./100 ml.

$[\eta]$C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
					Values of η_{rel}					
1	2.350	2.530	2.720	2.920	3.131	3.353	3.586	3.831	4.089	4.360
2	4.644	4.943	5.257	5.586	5.931	6.293	6.672	7.069	7.486	7.922
3	8.379	8.857	9.357	9.881	10.429	11.002	11.601	12.227	12.882	13.566
4	14.280	15.027	15.807	16.621	17.471	18.358	19.285	20.251	21.259	22.311
5	23.409	24.553	25.746	26.990	28.287	29.639	31.047	32.515	34.044	35.638
6	37.298	39.027	40.827	42.702	44.654	46.687	48.802	51.004	53.296	55.681
7	58.163	60.746	63.432	66.227	69.134	72.158	75.303	78.570	81.972	85.506
8	89.184	93.008	96.981	101.10	105.40	109.86	114.49	119.31	124.31	129.52
9	134.92	140.53	146.36	152.41	158.70	165.24	172.01	179.06	186.38	193.97

Table II. Relation Between Relative Viscosity (η_{rel}) and Intrinsic Viscosity ([η]) for Values of $[\eta]C = 2.50 - 3.49$

C = concentration in g./100 ml.

[η]C	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
					Values of η_{rel}					
2.5	6.2925	6.3297	6.3668	6.4043	6.4422	6.4800	6.5181	6.5561	6.5945	6.6330
2.6	6.6719	6.7107	6.7499	6.7892	6.8286	6.8682	6.9081	6.9482	6.9885	7.0288
2.7	7.0693	7.1102	7.1510	7.1922	7.2335	7.2752	7.3168	7.3588	7.4010	7.4432
2.8	7.4859	7.5285	7.5714	7.6146	7.6578	7.7015	7.7450	7.7890	7.8331	7.8776
2.9	7.9220	7.9668	8.0118	8.0569	8.1022	8.2069	8.1937	8.2397	8.2858	8.3321
3.0	8.3788	8.4257	8.4727	8.5199	8.5948	8.6152	8.6632	8.7112	8.7594	8.8081
3.1	8.8570	8.9059	8.9554	9.0047	9.0544	9.1043	9.1544	9.2049	9.2556	9.3064
3.2	9.3574	9.4086	9.4602	9.5120	9.5640	9.6164	9.6687	9.7214	9.7743	9.8277
3.3	9.8810	9.9347	9.9886	10.0429	10.0972	10.1519	10.2067	10.2618	10.3173	10.3730
3.4	10.4289	10.4849	10.5415	10.5982	10.6550	10.7121	10.7697	10.8270	10.8853	10.9434

use. Both of these could be designed to operate satisfactorily at a shear rate of about 50 sec.$^{-1}$. This shear rate of 50 sec.$^{-1}$ has the additional advantage that results obtained here more nearly approach those at zero rate of shear, which is the most theoretically sound condition of measurement (*3*, *4*).

No simple rapid means of determining viscosities at zero shear gradient has been proposed. Hall and Fuoss (*6*), Fox, Fox, and Flory (*7*), and Akkerman, Pals, and Hermans (*8*) have described methods of determining viscosities at zero rate of shear which involve making measurements at a number of rates of shear and extrapolating to zero. Any such procedure is too time consuming for use in a rapid control test.

SUMMARY AND FUTURE WORK

The experimental work reported here is in the nature of a progress report. Six samples of cellulose, varying in D.P. from approximately 400 to 4000, were studied (Table III). These samples were dissolved in cuprietheylenediamine (cuprien), by means of a two-stage technique as in TAPPI method T 230 sm-50. Measurements were made at $C = 3/[\eta]$.

Table III. Description of Six Cellulose Samples Studied

Designation	Description	Approx. D.P.
1	Viscose-grade chemical cotton, low viscosity	400
2	High quality nitrate plastics-grade chemical cotton	1000
3	Acetate plastics-grade chemical cotton, low soda solubles	1800
4	Acetate plastics-grade chemical cotton, soda solubles lower than sample 3	2300
5	Acetate plastics-grade chemical cotton, soda solubles lower than sample 4	2700
6	Kierboiled Memphis cotton	4000

For samples of intrinsic viscosity below 10, viscosity is independent of the rate of shear within the accuracy

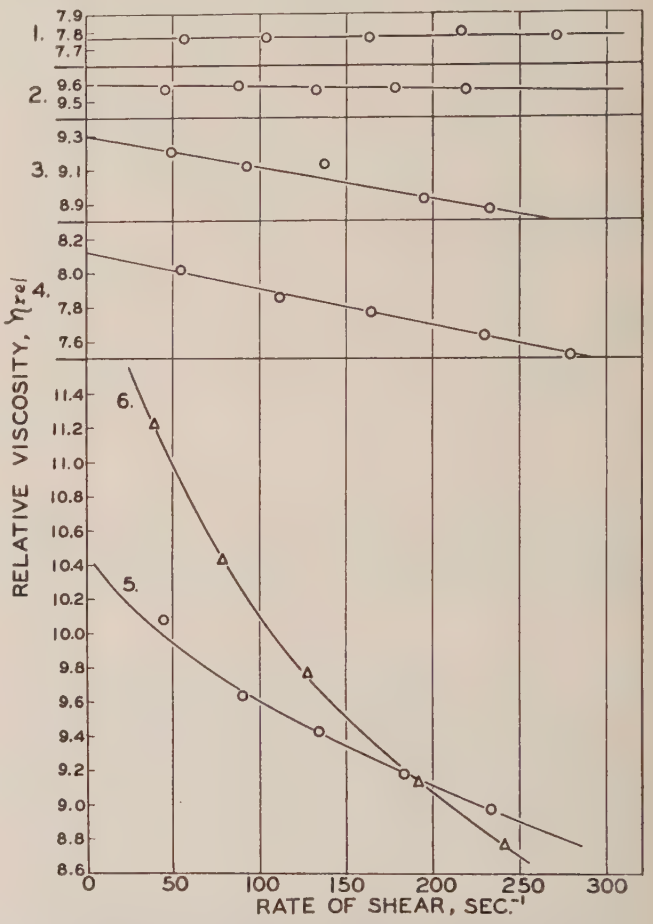

Fig. 1. Data obtained from the Wagner-Russell viscometer for the six cellulose samples

of the measurements. Solutions of the samples are therefore Newtonian, and the same viscosity will be obtained from all conventional viscometers. For samples of intrinsic viscosity above 10 (Fig. 1), shear sensitivity must definitely be considered. Solutions of

Table IV. Variation of η_{rel} with Rate of Shear

Sample	No. 2 Ubbelohde η_{rel}	No. 2 Ubbelohde Approx. shear rate, sec.$^{-1}$	No. 1 Ubbelohde η_{rel}	No. 1 Ubbelohde Approx. shear rate, sec.$^{-1}$	Wagner-Russell η_{rel}	Wagner-Russell Shear rate, sec.$^{-1}$	Wagner-Russell η_{rel}	Wagner-Russell Shear rate, sec.$^{-1}$	Brookfield η_{rel}	Brookfield Shear rate, sec.$^{-1}$	Wagner-Russell η_{rel}	Wagner-Russell Shear rate, sec.$^{-1}$
1	7.70	723	7.69	256	7.76	164	7.76	57	8.0	30	...	..
3	8.40	557	8.80	230	8.93	195	9.20	49	9.4	30	...	..
4	7.28	640	7.68	255	7.77	104	8.02	54	8.3	30	8.43[a]	0
6	7.20	655	8.12	241	9.13	190	9.65[a]	50	11.3	30	10.3[a]	0

[a] Extrapolated values.

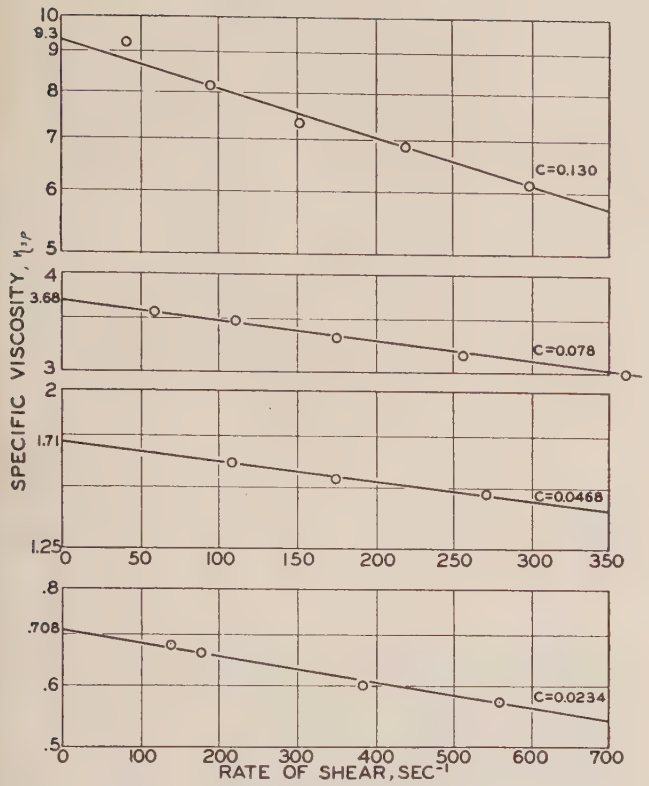

Fig. 2. Extrapolation of η_{sp} to zero rate of shear for the concentrations noted

the latter samples are non-Newtonian in varying degrees and any viscosity determination on these solutions is questionable for purposes of independent comparison, unless the conditions under which such determinations were made are carefully defined (Table IV). However, the effect of this shear sensitivity can be greatly minimized by determining viscosity as near zero shear rate as is practical and, moreover, by converting viscosity to intrinsic viscosity.

For two of the higher D.P. samples, intrinsic viscosities at zero shear rate were obtained by the laborious procedure of measuring viscosity at several shear rates for each of four concentrations, extrapolating the results for each concentration to zero shear rate by suitable means, and extrapolating the zero shear rate results to zero concentration on the conventional semi-

Table V. η_{sp} Values Obtained at $\dot{\gamma} = 0$ by Two Methods

Concentration in grams per 100 ml. of solvent	0.130	0.078	0.0408	0.0234
η_{sp} from Fig. 4	9.30	3.68	1.71	0.708
η_{sp} from Fig. 5	9.81	3.77	1.71	0.710

log plot (Figs. 2, 3, and 4; Table V). Comparison of intrinsic viscosity values so determined may be made with one-point intrinsic viscosity values in Table VI.

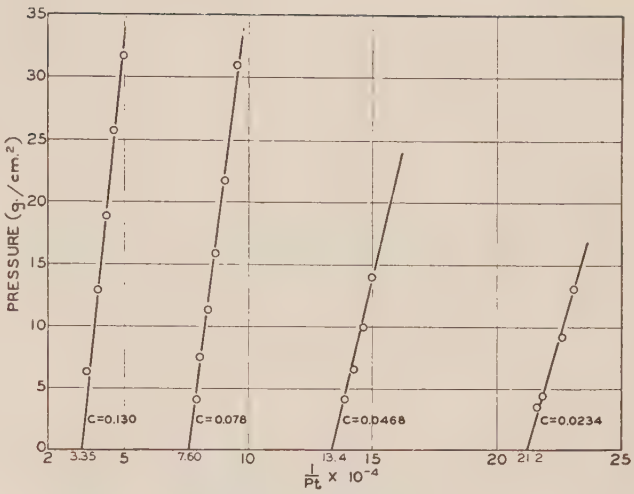

Fig. 3. Extrapolation of 1/Pt to zero pressure

Figure 5 summarizes the data and shows that the variation of intrinsic viscosity with shear sensitivity is qualitatively linear. The results indicate that for cellulose of intrinsic viscosity of 10 or below, the intrinsic viscosity may be accurately determined by the one-point method in any conventional viscometer, regardless of rate of shear. For celluloses whose intrinsic viscosity is between 10 and 16, viscosity determinations should be carried out at shear rates no higher than 50 sec.$^{-1}$. Instruments such as the Wagner-Russell and Brookfield viscometers can operate at this rate of shear, and intrinsic viscosities are easily obtained by the one-point method. For samples of intrinsic viscosity above 16, large effects of rate of shear are noted even at 50 sec.$^{-1}$. However, viscosity determinations at 50 sec.$^{-1}$ and use of the one-point method give an intrinsic viscosity for these high D.P. samples that is much more accurate than those determined at higher shear rates and approaches more closely the theoretically sound value at zero shear rate. A "zero shear rate" intrinsic viscosity is experimentally tedious and complex.

This investigation will be expanded to study cuprammonium solutions (*12*) as well as cuprien, to investigate further the high D.P. range, and to modify the Wagner-Russell viscometer to make it less fragile and easier to operate.

EXPERIMENTAL

Instruments and Calibration

The Wagner-Russell viscometer (*4*, *5*) (cf. Fig. 6) was designed for the study of cellulose solutions of approximately 10 cp. viscosity, at rates of shear of 50 to 250 sec.$^{-1}$. The efflux time and therefore the rate of shear may be varied by adjusting liquid level in the

Table VI. Intrinsic Viscosities

Sample	$[\eta]$, *No. 1 dilution Ubbelohde*	*One-point method* $[\eta]$, *No. 2 Ubbelohde*	$[\eta]$, *No. 1 Ubbelohde*	$[\eta]$, *Wagner-Russell,* $\dot{\gamma} = 50$ *sec.*$^{-1}$	$[\eta]$, *Brookfield,* $\dot{\gamma} = 30$ *sec.*$^{-1}$	$[\eta]$, *Wagner-Russell,* C = 0 $\dot{\gamma} = 0$ *sec.*$^{-1}$
1	...	2.85	2.84	2.86	2.90	...
2	7.0	7.4	7.4	7.35	7.4	...
3	...	11.6	11.7	12.25	12.27	...
4	...	13.7	14.1	14.6	14.7	14.4
5	...	16.4	16.8	17.7	17.8	...
6	21.6	21.0	22.6	25.1	26.8	25.0

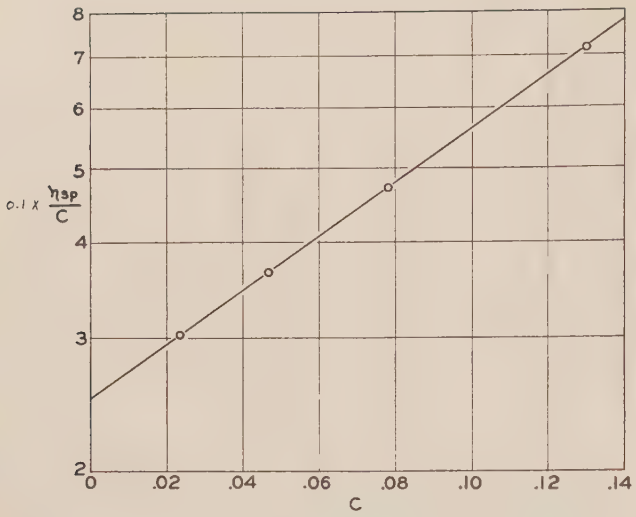

Fig. 4. Intrinsic viscosity plot for the highest D.P. sample, [η] = 25.0

outer tube of the viscometer. The side arm and stopcock are used for fine adjustments of the liquid level.

The dimensions of the viscometer were as follows:

Radius of the capillary = 0.050 cm.
Volume of the bulb = 1.817 ml.
Length of the capillary = 30.499 cm.

The capillary was Trubore; V was determined volumetrically, and L by use of a cathetometer. Therefore

$$\eta = 4.3448 \times 10^{-5}(h_m)(d)(t)$$

and

$$\dot{\gamma} = 1.8508 \times 10^{4}L/t$$

The viscometer was calibrated with two certified oils, obtained from the National Bureau of Standards, and water which had been distilled and degassed.

The results of these calibrations are given in Table VII.

Corrections for end and kinetic energy effects were found to be negligible, amounting to less than five-thousandths of a centipoise.

As mentioned earlier, a special Brookfield rotational viscometer (Fig. 7) has been studied for possible control use. The instrument is simple and rapid to operate, easily cleaned, and rugged in construction. This special viscometer utilizes two torsion springs, giving a working range from 0.1 to 20,000 cp. The dimensions of the bob and cup are such that the annulus is but 0.13 cm. wide, giving a rate of shear across the annulus that may be assumed constant for purposes here. The rate of shear may be varied from approximately 1 to 60 sec.$^{-1}$ by varying the revolutions per minute of the bob.

The Brookfield viscometer was calibrated with certified oils from the National Bureau of Standards. In the range from 10 to 35 cp., dial reading varies linearly with viscosity.

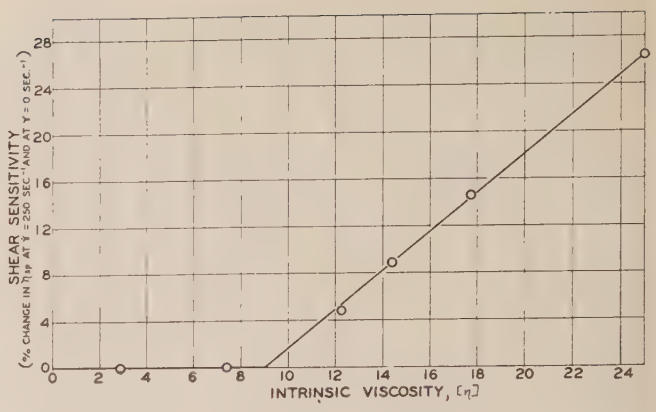

Fig. 5. Qualitative picture of shear sensitivity as a function of [η]

Procedure

Six samples of cellulose, varying in D.P. from approximately 400 to 4000, were studied. Description and designation of these samples are contained in Table III. For purposes of correct concentration, moisture content was also determined.

The cellulose samples were dissolved in cuprien,* by means of a two-stage technique as in TAPPI method T 230 sm-50. Sixty milliliters of 0.167 M cuprien under nitrogen are added to the sample in an evacuated vaccine bottle and the contents are shaken for 3 min., causing dispersion of the sample. Forty milliliters of 1.0 M cuprien are then added, causing immediate solution. The final concentration is 0.5 M cuprien (0.5 M in copper, 0.93 M in ethylenediamine). After the cellulose has dissolved, positive nitrogen pressure is placed on the solution. Required amounts of solution are then transferred to the viscometers by means of a hypodermic syringe. Solvent is made up as in the solution technique, and transfer and dilutions are accomplished by means of a hypodermic syringe. All determinations were carried out in a thermostat at 25.00 ± 0.01 °C.

The concentrations of the samples were adjusted so that the product $[\eta]C$ was equal to approximately 3. These solutions had viscosities of approximately 10 cp. and it was for this range that the modified Wagner-Russell was designed. It must be noted that *all* concentrations are expressed in grams of sample per 100 ml. of solvent, not per 100 ml. of solution. For the samples studied, this introduces a negligible error.

Table VII. Calibration of the Wagner-Russell Viscometer

Material	*Known viscosity, poise at 25°C.*	*Density, g./cm.³*	*Mean hydrostatic head, cm.*	*Time, sec.*	*Observed viscosity, poise at 25°C.*
Water	0.008937 (9)	0.99707	4.049	51.2, 51.2, 51.1	0.008982
			4.083	50.8, 50.8	0.008984
			4.048	51.1, 51.1	0.008962
Oil	0.1024	0.8378	14.824	189.2, 189.3	0.1021
			7.938	352.2, 352.2	0.1018
			14.813	189.2, 189.2	0.1020
Oil	0.3365	0.8614	20.723	433.0, 433.2	0.3359

* 1.0 M cuprien was obtained from the Ecusta Paper Corp., Pisgah Forest, N. C.

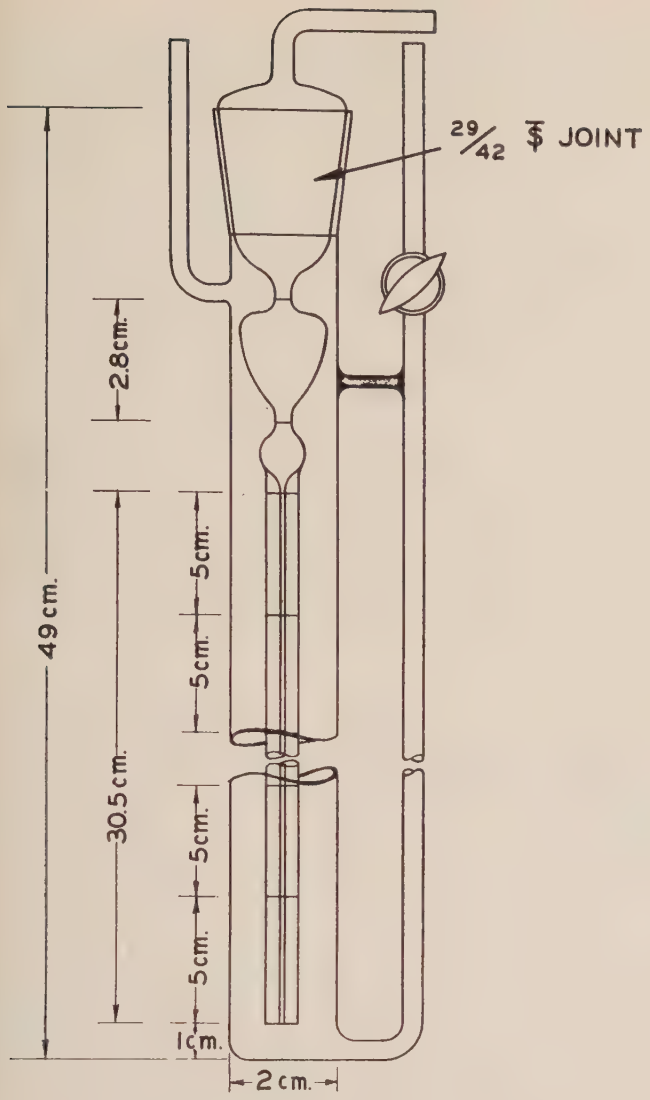

Fig. 6. Modified Wagner-Russell viscometer

Viscosities were calculated from the Poiseuille equation,

$$\eta = \frac{981\pi R^4 h_m d t}{8VL} \qquad (5)$$

where

η = viscosity, poise
R = capillary radius, cm.
h_m = mean hydrostatic head, cm.
d = density, g./cm.^{3}
t = efflux time, sec.
V = volume of the bulb, cm.^{3}
L = length of the capillary, cm.

In the above equation, h_m, the mean hydrostatic head, is calculated as that for a cylinder,

$$h_m = \frac{h_2 - h_1}{\ln h_2/h_1} \qquad (6)$$

where h_2 and h_1 are the distances, in centimeters, of the marks above and below the bulb, respectively, above the liquid level. The liquid level in the outer tube is the average of the levels when the capillary is filled to the marks above and below the bulb. The authors are indebted to W. E. Davis of this laboratory for the equation for the mean hydrostatic head over a sphere, which is:

$$h_m = \frac{{}^1/_6(h_2 - h_1)^3}{{}^1/_2(h_2^2 - h_1^2) - h_2 h_1 \ln h_2/h_1} \qquad (7)$$

The results of the two above equations are, for our purposes, substantially the same and the less cumbersome equation, i.e., that for a cylinder, has been utilized.

The rate of shear, $\dot{\gamma}$, has been calculated as:

$$\dot{\gamma} = \frac{4V}{\pi R^3 t} \qquad (8)$$

Here $\dot{\gamma}$ is the maximum rate of shear at the capillary wall for a Newtonian liquid in the units of sec.$^{-1}$. It may be shown (*10*), for a rotational viscometer, that:

$$\dot{\gamma} = \frac{2\omega}{r^2(1/R_B^2 - 1/R_C^2)} \qquad (9)$$

where

$\dot{\gamma}$ = the average rate of shear
ω = the angular velocity of the bob (radians)
R_B = radius of the bob, cm.
R_C = radius of the cup, cm.
r = average radius, cm., $= (R_B + R_C)/2$

Use of this relationship shows that on the low viscosity scale, revolutions per minute is roughly equal to the average rate of shear in sec.$^{-1}$, i.e., 12 r.p.m. represents a shear rate of 13 sec.$^{-1}$, etc. It can be shown that the values for average and maximum rates of shear are very close for this instrument.

Precautions

The major experimental difficulties are the accurate determination of the mean hydrostatic head and the fragility of the capillary tube. The former presents a twofold problem. With colorless liquids the meniscus is easily seen but for colored solutions such as cuprien, a small spotlight behind the viscometer is a necessity. Moreover, the height of head must be very accurately measured. Reference marks are placed at 5-cm. intervals along the capillary tube and the distances between these graduations and the marks above and below the bulb are measured by use of a cathetometer. The position of the liquid level is read, relative to the reference mark above the meniscus, by use of a cathetometer. A head of less than 5 cm. is inadvisable. The fragility of the capillary tube demands careful handling Subsequent modifications may partially circumvent this problem.

Experience indicated that for short periods of time the cuprien solutions were stable in the presence of air. Longer determinations such as that for multipoint intrinsic viscosity were either run under positive nitrogen pressure or blanketed with nitrogen. All Brookfield determinations were run under a stream of nitrogen, delivered through the side of the sleeve. This was done to prevent any harmful effects to the torsion springs by cuprien vapors.

Fig. 7. LVT-RVT Brookfield viscometer

Results and Discussion

The viscosity of the solvent, 0.5 *M* cuprien, as determined in three different Ubbelohde viscometers, was found to be 1.199 cp. This value for η_0 was used throughout the study.

In Fig. 1 the rate of shear is plotted against η_{rel} for all six samples. All data were obtained from the Wagner-Russell viscometer. For the two samples of lowest D.P., the viscosity is independent of the rate of shear within the accuracy of the measurements. These solutions are, therefore, Newtonian and the viscosity as determined in any conventional viscometer is constant. However, for the four remaining samples, shear sensitivity must be considered. The solutions are non-Newtonian, and the result of any viscosity determination on these is questionable for purposes of independent comparison because of the shear dependence of the measured quantity. This is clearly shown in Table IV. The rates of shear in the two models of Ubbelohde viscometers used are comparable to those used by TAPPI and by previous workers (*3*, *4*). The large effects of rate of shear on apparent viscosity and, consequently, on η_{rel}, as shown in Table IV, emphasize the often unconsidered error introduced by rate of shear. This error assumes magnitudes as high as 30% for samples of higher D.P., even in the relatively dilute solutions investigated, and obviously must be considered.

Moreover, some time effects, i.e., tendency of apparent viscosity to decrease slightly at a constant rate of shear, have been noted for samples of higher D.P. However, at rates of shear below approximately 200 sec.$^{-1}$, for solutions where $[\eta]C = 3.0 \pm 0.5$, these time effects are not detectable.

A sound compromise appears to be determination of η_{rel} at $\dot{\gamma} = 50$ sec.$^{-1}$ for samples with D.P.'s up to 2500. Time effects are not noted and the values of η_{rel} are much closer to the theoretically sound value where $\dot{\gamma} = 0$. Values of η_{rel} may be obtained at $\dot{\gamma} = 50$ sec.$^{-1}$ by either the Wagner-Russell or the commercially available Brookfield viscometer. The values are experimentally determined, and are not corrected or extrapolated values. The desirability of measurement at $\dot{\gamma} = 50$ sec.$^{-1}$ is therefore evident.

Even more advantage is to be gained by use of $[\eta]$. Since the relation between η_{rel} and $[\eta]$ is exponential, a relatively large change in η_{rel} becomes a small change in $[\eta]$. Therefore, the effect of rate of shear on $[\eta]$ and, ultimately, on the determined D.P., is relatively reduced. Moreover, by use of the Martin equation and tables, $[\eta]$ is a quantity as easily determined, in most instances, as the viscosity.

To show the smaller effect of rate of shear on $[\eta]$, $[\eta]$ values for all six samples were determined in several ways. These are shown in Table VI. The intrinsic viscosities of samples 2 and 6 were determined in a no. 1 dilution Ubbelohde (*11*). By using the Martin equation and the one-point intrinsic viscosity method, $[\eta]$ values for samples 1 through 6 were obtained. As is noted in Table VI, the η_{rel} values used for the Martin one-point method were obtained from four different sources: a no. 2 Ubbelohde viscometer where γ is approximately 600 sec.$^{-1}$, a no. 1 Ubbelohde viscometer where $\dot{\gamma}$ is approximately 250 sec.$^{-1}$, a Brookfield for a $\dot{\gamma}$ of 30 sec.$^{-1}$, and the Wagner-Russell data (cf. Fig. 3) for a $\dot{\gamma}$ of 50 sec.$^{-1}$. Samples 1 and 2, being Newtonian, illustrate good agreement between Ubbelohde, Brookfield, and Wagner-Russell viscometers. Such precision cannot always be expected from the Brookfield, however, and in this case a precision of 1 to 3% is usual.

Consideration of the intrinsic viscosities obtained by the one-point method in Table VI shows that, while for samples 3 through 6 shear effects are evident, the effect is not nearly so large as the effect of rate of shear on η_{rel}. The one-point method is good for the Newtonian solutions, and fairly good for samples 3 and 4, if the η_{rel} of the latter samples is determined at a rate of shear below 250 sec.$^{-1}$. Determination of η_{rel} at $\dot{\gamma} = 50$ sec.$^{-1}$ is preferable and is easily obtained.

In order to make certain that the effect of rate of shear on samples in the range of samples 3 and 4 is relatively small and in order to determine more exactly the magnitude of the effect of rate of shear in samples in the region of 5 and 6, a "zero rate of shear" intrinsic viscosity seemed advisable for representative samples in the two above ranges. Such $[\eta]$ values were obtained for samples 4 and 6.

The variation of η_{sp} with $\dot{\gamma}$ at several different concentrations was required, so that η_{sp} at zero shear rate could be obtained by extrapolation at each concentration. A plot of $\dot{\gamma}$ versus η_{rel} or η_{sp} proved to be nonlinear for samples of higher D.P. and extrapolation was therefore inaccurate. However, two other methods of extrapolation proved satisfactory. The log of η_{sp} varies linearly with the rate of shear (*7*) and this yields a value of η_{sp} at $\dot{\gamma} = 0$. Such plots for four concentrations of sample 6 are seen in Fig. 2. Comparable results are obtained from a plot of pressure (mean hydrostatic head times density) versus the reciprocal of the product of pressure and time (*6*, *8*). Such a plot is shown in Fig. 3. Values of η_{sp} at $\dot{\gamma} = 0$, obtained by the two methods, are shown in Table V.

By using the values of η_{sp} as obtained above, a conventional intrinsic viscosity plot (log η_{sp}/C versus C), where C is concentration in grams of sample per 100 ml. of solvent, was made. This is shown in Fig. 4. It is seen that the $[\eta]$ at zero shear rate is equal to 25.0. The slope constant, K', is 0.32, which agrees rather well with $K' = 0.30$ for the Martin equation. Comparison of the intrinsic viscosity of sample 6 as determined in various ways may be made from Table IV. It will be noted that $[\eta]$ from Brookfield data is rather high. The agreement between the Wagner-Russell and the Brookfield is poorer for samples of higher D.P. than for those of lower D.P.

The intrinsic viscosities at zero shear rate for sample 4 were determined in a manner identical to that for sample 6. As is shown in Table IV, $[\eta]$ so determined equals 14.4. The slope constant, K', is 0.34, again in rough agreement with that for the Martin equation. This $[\eta]$ value may be compared with other $[\eta]$ values as determined at shear rates up to 600 sec.$^{-1}$, in Table VI.

The data are best summed up graphically. In Fig. 5 $[\eta]$ is plotted versus "shear sensitivity," the latter quantity representing the per cent change in η_{rel} at $\dot{\gamma} = 0$ and at $\dot{\gamma} = 250$ sec.$^{-1}$. The variation of these intrinsic viscosities with "shear sensitivity" is qualitatively linear.

SUMMARY OF RESULTS

For cellulose which has intrinsic viscosities of 10 or below, the region of greatest interest to the paper industry, η_{rel} may be accurately determined in any conventional viscometer, regardless of rate of shear. The $[\eta]$ value may be easily and quickly obtained by use of the Martin equation.

The viscosities of solutions of cellulose whose $[\eta]$ = 10 to 16, are affected by rate of shear. It is strongly recommended that the η_{rel} of such solutions be determined at a rate of shear of 50 sec.$^{-1}$. However, $[\eta]$ may be obtained with moderate accuracy from η_{rel}, determined at shear rates as high as 250 sec.$^{-1}$, and subsequent use of the Martin equation.

For high D.P. cellulose whose $[\eta]$ is above 16, large effects of rate of shear on η_{rel} are found, even at very low rates of shear. However, use of η_{rel}, as determined at $\dot{\gamma}$ = 50 sec.$^{-1}$, and the Martin equation yields an $[\eta]$ that is relatively accurate and easily obtained. Evaluation of $[\eta]$ at "zero shear rate" is more reliable but is experimentally tedious and complex.

LITERATURE CITED

1. Martin, A. F., *Tappi* 34: 363 (1951).
2. Martin, A. F., Am. Chem. Soc. meeting, Atlantic City, Sept. 14–19, 1952.
3. Conrad, C. M., *Ind. Eng. Chem., Anal. Ed.* 13: 526 (1941).
4. Wilson, K., *Svensk Papperstidn.* 55: 125 (1952).
5. Wagner, R. H., and Russell, J., *Anal. Chem.* 20: 151 (1948).
6. Hall, H. T., and Fuoss, R. M., *J. Am. Chem. Soc.* 73: 265 (1951).
7. Fox, T. G., Jr., Fox, J. C., and Flory, P. J., *J. Am. Chem. Soc.* 73: 1901 (1951).
8. Akkerman, F., Pals, D. T. F., and Hermans, J. J., *Rec. trav. chim.* 71: 56 (1952).
9. Bingham, E. C., and Jackson, R. F., *J. Research Natl. Bur. Standards* 14: 75 (1918).
10. Green, H., "Industrial Rheology and Rheological Structures," New York, John Wiley and Sons, Inc., pages 35–58, 1949.
11. Davis, W. E., and Elliott, J. H., *J. Colloid Sci.* 4: 313 (1949).
12. Browning, B. L., Progress Report I to TAPPI, June 25, 1952.

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A Study of the Alkaline Nitrobenzene Oxidation of Chlorite Lignin

JACK E. JAYNE

Chlorite lignin preparations recovered from acidified chlorite holocellulose liquors of slash pine and black spruce were subjected to alkaline nitrobenzene oxidations. Vanillin, 6-chlorovanillin, and vanillic acid were isolated in maximum yields of 3.7, 2.3, and 5.3% (based on chlorite lignin), clearly establishing that chlorite lignin is built up from guaiacyl nuclei as is the lignin from which it was derived. The partially oxidized nature of chlorite lignin, previously indicated by its high carboxyl content, was confirmed by a higher ratio of acid to aldehyde than is found in similar treatments of wood or other lignin preparations. Extensive use was made of chromatographic analysis to achieve separations not possible by other techniques. Chromatographic evidence indicated the absence of 5-chlorovanillin among the products of the oxidation; likewise, no appreciable quantity of 6-chlorovanillic acid was formed. A new nitrobenzene reduction product, *p*-phenylazobenzoic acid, was isolated. Oxidations performed on vanillin, 6-chlorovanillin, and vanillic acid resulted in 74 to 81% recoveries of unchanged starting materials. The aldehydes were partially oxidized to the corresponding acids and also underwent partial demethylation to the corresponding dihydroxy compounds. The degradation products of vanillic acid did not include simple decarboxylated or demethylated compounds.

IN THE past 10 years there have been a number of investigations concerned with the action of acidic solutions of sodium chlorite on wood. On the one hand, the goal has been the isolation of a holocellulose which approaches the total carbohydrate fraction of the wood. Other investigators have examined the role of sodium chlorite as a bleaching agent. In either case, its usefulness depends upon its marked specificity as a solubilizing agent for lignin while leaving the cellulose largely intact.

Sohn and Reiff (*1*) were among the first to attempt a recovery of the material in chlorite liquors obtained from the digestion of wood with acidic solutions of sodium chlorite. They found that acidification of these liquors with strong acids produced a white flocculent precipitate which they believed to be hemicellulosic in nature.

Jayme and Hanke (*2*) recovered up to 50% of the weight of material removed during the chloriting of sprucewood; the products, having methoxyl and chlorine contents of 8.6 to 9.8 and 1.4 to 4.5%, respectively, were shown to contain from 20 to 28% of reducing sugars and from 5 to 10% of aldonic acids.

It remained for Barton (*3*) to recover a material from the chlorite liquor which was free of carbohydrate material. Acidification of the liquor produced a precipitate which was separated into a lignin and a carbohydrate fraction by alternate solution in dioxane and precipitation in ether. The lignin product, termed "chlorite lignin A," was characterized by acetylation and methylation studies; a unit weight of 600 had associated with it two carboxyl groups, two methoxyl groups, one chlorine atom, and two nonphenolic hydroxyl groups. The highest yield of chlorite lignin A, based on the original wood, was 2.75%.

Bublitz, working with black sprucewood, isolated a product similar to Barton's chlorite lignin A by electrodialyzing the concentrated chlorite liquor and treating the purified liquor with an excess of alcohol. The resulting precipitate was purified by solution in dioxane

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and precipitation into ether; it had a methoxyl content of 12.5% and a chlorine content of 4.0% and was recovered in a yield of 4.8% (based on the original wood).

Wacek and Schroth (*5*) have recently isolated an acidic material from a tropical wood and from sprucewood by acidification of the 24% potassium hydroxide extract of the chlorite holocellulose. The product was shown to be free of carbohydrate material. The substance they obtained from a tropical wood had a methoxyl content of 16.5% and a "slight" chlorine content; it was oxidized with alkaline nitrobenzene and yielded vanillin, syringaldehyde, and syringic acid. The corresponding substance from sprucewood, having a methoxyl content of 12.4% and a chlorine content of 3.3%, was oxidized with peracetic acid and nickel acetate to vanillic acid.

The identification of the fragments of oxidative degradations performed on lignin was not widely used until the introduction of alkaline nitrobenzene as an oxidizing agent (*6*); since that time, numerous investigations have been performed with this medium on many different lignin preparations or model compounds and have contributed much to the knowledge of lignin (*7–12*). Accordingly, this technique was chosen in the study of chlorite lignin.

In addition to vanillin and vanillic acid which are ordinarily found as lignin oxidation products, the presence of a chlorinated product was anticipated; Pearl (*13*) isolated 6-chlorovanillin from the steam nonvolatile aldehyde fraction of the ether extract obtained from the chlorite liquor of a black sprucewood holocellulose digestion. Lautsch and Piazolo (*14*) isolated 6-bromovanillin by treating cuoxam spruce bromolignin with 10% potassium hydroxide and oxygen in the presence of cobaltic hydroxide. They found no 5-bromovanillin, although the free phenolic groups in lignin have a strong orienting influence to the ortho position and make substitution in the 5-position likely; 5-chlorovanillin was prepared by Barton (*15*) by the reaction of sodium chlorite on vanillin itself. 5-Iodovanillin was produced by Lautsch and Piazolo (*14*) from cuoxam spruce iodolignin but this preparation was made through the intermediate acetomercury cuoxam lignin compound.

STARTING MATERIALS

Chlorite lignin A was prepared by Barton (*3*) from slash pinewood in the following way.

Wood meal, extracted with alcohol benzene, was digested with sodium chlorite and acetic acid for 4.5 hr. under the conditions shown in Table I.

Table I. Chloriting Conditions

Extracted wood meal, g.o.d.	1800
Consistency of solution, %	6
Temperature, °C.	75–80
Length of cook, hr.	4.5
Amount of $NaClO_2$ (based on wood), %	110
Rate of $NaClO_2$ addition, g./hr.	495
pH maintained by addition of acetic acid	4.5–4.6

The holocellulose was filtered and washed with water, yielding a liquor which was aerated and further acidified with sulphuric acid. The flocculent precipitate which formed was collected by filtration and triturated with dioxane. Dehydration and precipitation of the dioxane-soluble materials into ether yielded chlorite lignin A. Table II describes the product which Barton obtained from his "cook 7."

Table II. Chlorite Lignins Used as Starting Materials

	Barton, %	*Bublitz, %*
Yield (based on wood)	1.7	4.8
Yield (based on Klason lignin content of wood)	6.1	17.3
Methoxyl	10.6	12.5
Chlorine	7.5	4.0

Chlorite lignin was prepared by Bublitz (*4*) from black sprucewood. The chloriting procedure approximated that used by Barton (see Table I) but the liquor treatment was modified.

The liquor and washings were concentrated and electrodialyzed. After further concentration the purified liquor was treated with 8 volumes of alcohol. The resulting finely divided precipitate was removed by filtration and washed with alcohol. The alcoholic filtrate and washings, further concentrated to a thick syrup, were triturated with dioxane; dehydration and precipitation of the dioxane-soluble materials into ether yielded the final chlorite lignin product. A portion of the product was further purified by successive suspensions in ether and low boiling ether; it had a methoxyl content of 12.5% and a chlorine content of 4.0% (see Table II).

Vanillin was U.S.P. grade.

6-Chlorovanillin was prepared from vanillin according to the procedure of Raiford and Lichty (*16*).

Vanillic acid was prepared from vanillin by oxidation with silver oxide (*17*).

OXIDATION PROCEDURES

With the exception of oxidation 4, all oxidations were carried out in a 420-ml. stainless steel bomb (26 mm. inside diameter and 80 cm. in length) fitted with a threaded plug containing a thermometer well and sealed with a lead or copper gasket. The bomb was placed within an electrically heated jacket which was rocked 36 times a minute through an angle of approximately 30°.

Oxidation 4 was carried out in a 1-gal. autoclave equipped with a spade-type strirrer which rotated 36 times a minute. Heating was achieved through the use of a large gas burner placed under the autoclave.

The reactant ratios were arbitrarily based on those of Freudenberg and co-workers (*7*); for each 7.5 grams of material to be oxidized there were added 17.5 ml. of nitrobenzene and 300 ml. of 2 *N* sodium hydroxide.

Oxidations 1 through 7 were arbitrarily assigned the heating conditions used by Freudenberg and co-workers (*7*)—namely, 3 hr. at 160°. Oxidation 8 was carried out under Leopold's conditions—2 hr. at 180° (*11*). Oxidation 9 was kept at 160° for 3 hr. but the heating and cooling periods were extended somewhat (see Table III).

ORIENTATIVE OXIDATIONS

Oxidations 1, 2, and 3 comprised a series of orientative experiments intended to ascertain the yield of simple compounds and the identity of the major products, and to help choose the best separation techniques to be used in later work.

Oxidation 1 was performed on 7.5 grams of Barton's chlorite lignin A; a composite of several smaller samples

Table III. Summary of Oxidations

	Oxidation Number								
	1	2	3	4	5	6	7	8	9
Weight of starting materials, g.[a]	7.5	7.5	22.5[b]	79.0[c]	7.5	7.5	6.8	7.5	7.5
Time to temperature, min.	45	45	45	40	45	45	45	45	85
Reaction temperature, °C.	160	160	160	160	160	160	160	180	160
Time at temperature, hr.	3	3	3	3	3	3	3	3	3
Cooling time to 80°C., min.	60	60	60	150	60	60	60	90	120
Yield of vanillin, %[d]	..	..	...	3.7	75	..	..	0.9	0.6
Yield of 6-chlorovanillin, %	..	..	1	2.3	..	81	..	2.3	2.3
Yield of vanillic acid, %	2	..	...	5.3	0.8	..	74	4.5	4.2

[a] Starting materials used were as follows:
Oxidations 1–3—Barton's chlorite lignin A
Oxidation 4 —Bublitz' chlorite lignin
Oxidation 5 —Vanillin
Oxidation 6 —6-Chlorovanillin
Oxidation 7 —Vanillic acid
Oxidations 8, 9—Barton's chlorite lignin A
[b] Oxidation 3 was carried out in three separate reactions, each on 7.5 grams of starting material.
[c] Oxidation 4 was carried out in a stirring autoclave; all others were run in a rocking bomb.
[d] All yields are based on the weight of starting material.

was used on which no analysis for methoxyl or chlorine content was made. The reaction products, after removal of nitrobenzene and its reduction products by steam distillation and benzene extraction, were acidified and extracted with ether. The ether extract was fractionated by successive extractions with 21% sodium bisulphite, saturated sodium bicarbonate, and 5% sodium hydroxide solutions. Acidification of the bicarbonate extract yielded a product which, after a chromatographic treatment on acid-washed Magnesol (*18*) with 100:1 benzene-ethanol developer, was found to contain vanillic acid. The acidified bisulphite extract also yielded a small amount of vanillic acid. No other products of oxidation 1 were identified.

Oxidation 2 was also performed on 7.5 grams of Barton's chlorite lignin A as described in oxidation 1. The reaction products, after benzene extraction and acidification, were ether extracted; the order of fractionation of the ether extract was modified by reversing the bisulphite and bicarbonate extractions, resulting in the appearance of almost all the ether-soluble material in the bicarbonate extract from which was recovered a small amount of vanillic acid. No other lignin oxidation products were identified, despite the application of different crystallizing solvents or attempts at fractionation by steam distillation or sublimation. However, the sodium hydroxide extract was found to contain a nitrobenzene reduction product, *p*-hydroxyazobenzene; its formation is not to be attributed to the specific reducing action of chlorite lignin inasmuch as other investigators have reported its formation in work on lignin model compounds or other lignin preparations (*7*, *11*).

The appreciable water solubility of some of the lignin oxidation products may cause them to appear in fractions other than those which their functional groups would dictate when the separation is based on partition between ethereal and aqueous phases. Accordingly, the separation of the products of oxidation 3 was undertaken by a method which should depend solely upon differences in acidity. For the purpose, the use of an anion-exchange column was developed.

Duolite A-3 (Chemical Process Co.) was shown to be suitable for the separation of vanillin and vanillic acid. Sixty milliliters of the resin contained in a 21.5-mm. diameter glass tube were extracted repeatedly with hot ethanol to prevent contamination of samples during later work. Regeneration was accomplished with 250 ml. of *N* sodium hydroxide solution (all flow rates are 2 to 2.5 ml. per min.) followed by the overnight passage of distilled water. The column was then conditioned by the application of 120 ml. of 50% ethanol.

A solution containing 5 grams of vanillin and 2.5 grams of vanillic acid in 180 ml. of 50% ethanol was applied to the column and followed by 370 ml. of 50% ethanol. Evaporation of the 550 ml. of effluent yielded 4.93 grams of crude vanillin, representing a recovery of 98.5%. Vanillic acid was eluted from the resin by the passage of 130 ml. of *N* sodium hydroxide. Acidification of the eluate yielded 2.34 grams of vanillic acid, representing a recovery of 93.4%.

In view of the nearly quantitative separation of vanillin and vanillic acid, the column was used in the separation of the products of oxidation 3, in which 22.5 grams of Barton's chlorite lignin A were used. After removal of nitrobenzene reduction products by steam distillation and benzene extraction, the products of the reaction were acidified, saturated with sodium chloride, and extracted with ether. The contents of the ether extract, weighing 11.0 grams, were dissolved in 110 ml. of ethanol and diluted with 110 ml. of water. The solution was passed through an anion-exchange column regenerated and conditioned in the manner just described. The application of the solution was followed by the passage of 1150 ml. of 50% ethanol.

The eluate, totaling 1260 ml., was concentrated, saturated with sodium chloride, and extracted with ether. The ether extracts were in turn extracted with 21% sodium bisulphite and 5% sodium hydroxide solutions. The bisulphite extracts, after acidification and heating, yielded 0.86 gram of product which was crystallized to form 0.24 gram of crude 6-chlorovanillin. A chromatographic purification on acid-washed Magnesol yielded 6-chlorovanillin which, after crystallization from dilute ethanol, melted at 165 to 167.5°. No depression was observed in a mixed melting point with an authentic sample.

A paper partition chromatographic method for separating vanillin, 6-chlorovanillin, and 5-chlorovanillin from one another on a qualitative basis was developed and applied to the mother liquors obtained from the crystallizations performed on the bisulphite-soluble materials described above. Vanillin and 6-chlorovanillin were shown to be present but there was no chromatographic evidence for the presence of 5-chlorovanillin. The analysis was made in the following manner.

A small sample of the unknown mixture and samples of known compounds for comparison purposes were dissolved in 95% ethanol and several drops of each solution were applied as spots near the upper end of a sheet of Whatman no. 1 filter paper. The deposited materials were carried down the sheet by a developer into which the upper end of the sheet was immersed. The operation was carried out in a closed glass cylinder the atmosphere of which was saturated with the developing agent.

After some experimentation, butanol saturated with 2% aqueous ammonia was found to separate satisfactorily the three compounds in question. Their positions on the sheet were determined by spraying the paper with a solution of aniline hydrogen phthalate (0.093 gram of aniline and 1.66 grams of phthalic anhydride in 100 ml. of water-saturated butanol). A bright yellow color appeared which was accentuated by heating briefly in a 105° oven. Vanillin at R_F 0.36 exhibited a distinctive green fluorescence when viewed under ultraviolet light; this aided in differentiating it from 5-chlorovanillin at R_F 0.46 which showed no fluorescence. 6-Chlorovanillin at R_F 0.66 did not fluoresce.

The acidic materials of oxidation 3 were removed from the anion-exchange column by elution with 190 ml. of 5% sodium hydroxide. Acidification of the eluate produced a brown oil from which vanillic acid could not be recovered. This failure of the technique to yield an acidic fraction from which simple compounds could be recovered caused the method to be discarded, despite the promise which was shown in the separation of vanillin and vanillic acid from one another.

As in oxidation 2, *p*-hydroxyazobenzene was recovered from the 5% sodium hydroxide extract of the materials not retained on the anion-exchange resin.

Oxidation 4

The orientative oxidations indicated that successive extractions with bisulphite, bicarbonate, and sodium hydroxide solutions constituted the best separation technique to apply to the products of the oxidation. Accordingly, this scheme was used to obtain the major fractions of a large-scale oxidation performed on 79.0 grams of Bublitz' chlorite lignin (see Table II for analysis).

The steam-distilled and ether-extracted reaction products were acidified with sulphuric acid and extracted with ether. An ether-insoluble product which separated at this point was purified by repeated trituration with anhydrous ether, solution in dioxane, and precipitation into ether; analysis showed it to contain 9.8% of methoxyl and 3.5% of chlorine. These values only slightly lower than the corresponding analysis of the starting material, suggest that a portion of the chlorite lignin was not appreciably degraded to simple compounds during the oxidation but was either unchanged or further polymerized.

The ether-soluble oxidation products were shown, by analysis of an aliquot, to weigh 38.9 grams and to contain 13.0% methoxyl and 2.9% chlorine. If correction is made for the yield of *p*-hydroxyazobenzene which cannot be attributed to the chlorite lignin, it is seen that the yield of ether-soluble oxidation products to be attributed to chlorite lignin and based on chlorite lignin is 46%.

The ether-soluble oxidation products were fractionated by successive extractions with 21% sodium bisuphite, saturated sodium bicarbonate, and 5% sodium hydroxide solutions. As was shown in oxidation 3, both vanillin and 6-chlorovanillin were to be found in the bisulphite-soluble fraction. Fractional crystallization could not be successfully applied to a mixture of these closely related compounds; accordingly, a chromatographic technique was developed.

In view of the successful separation of vanillin and 6-chlorovanillin on a qualitative basis by a paper partition chromatogram using butanol saturated with 2% aqueous ammonia as developer, a series of preliminary experiments was performed to extend the technique to a quantitative basis. The following procedure was adopted.

Whatman standard grade powdered cellulose was packed in a glass tube in ten sections, each of which was thoroughly tamped into place with a cork plunger. A perforated porcelain plate covered with glass wool supported the bottom of the column. The completed column was 30 mm. in diameter and 360 mm. in length.

The column was washed successively with 500 ml. of water, 500 ml. of 50% ethanol, and 500 ml. of butanol-aqueous ammonia; the flow rate was approximately 50 ml. per hr.

The crude mixture of vanillin and 6-chlorovanillin (weighing from 300 to 500 mg.) was mixed intimately with an equal volume of powdered cellulose and applied in a uniform layer to the top of the cellulose column. Butanol-aqueous ammonia was then applied as developer to the top of the column. The eluate was checked periodically by collecting a drop on a filter paper and treating it with 2,4-dinitrophenylhydrazine reagent. Vanillin and 6-chlorovanillin gave colors differing slightly in shade and indicated the proper time for changing eluate receivers. The fractions were concentrated and the residues triturated with petroleum ether; after removal of insoluble material by filtration the filtrates yielded crystalline products of good purity.

The bisuphite-soluble fraction of oxidation 4 was separated into three fractions by application to a column of acid-washed Magnesol and development with 100:1 benzene ethanol. The upper and center zones, after further chromatographic purification, yielded vanillic acid in an amount corresponding to a yield of 3.2% (based on chlorite lignin).

The lower zone, after separation on a powdered cellulose column according to the technique just described, yielded vanillin and 6-chlorovanillin in yields of 3.7 and 2.3%, respectively (based on chlorite lignin).

The bicarbonate-soluble fraction of oxidation 4 yielded vanillic acid by three different techniques. Sublimation at 130°/0.2 mm. was used on one portion of the fraction. Another portion was separated by application to a column of powdered cellulose similar to that described but with several variations. The powdered cellulose was packed in a tapered glass column; instead of collecting eluate fractions, the column was extruded and cut into zones as determined by the fluorescence shown when viewed by ultraviolet light. The principal zone, upon elution with 50% ethanol or acetone, yielded vanillic acid of good purity.

It was found that, if the bicarbonate-soluble fraction was mixed with powdered cellulose and applied in a narrow band to the top of the column, development

produced a chromatogram in which there was serious skewing of the pattern—deep "stabs" were found. This difficulty was solved by applying the acidic fraction as a fairly dilute solution dissolved in a portion of the developer. As development proceeded, discrete bands were formed in very uniform zones. This behavior was quite unexpected, being more characteristic of adsorption chromatography rather than of partition chromatography; the latter technique usually is the more successful, the narrower the area of application.

A third portion of the acid fraction of oxidation 4 was separated on a paper partition chromatogram. A strip of heavy filter paper (Whatman 3M) was treated in the manner described for qualitative separations, except that the sample was applied from a butanol solution to a fine line extending across the width of the sheet. The developed chromatogram was examined under ultraviolet light and the major zone eluted with 50% ethanol to yield vanillic acid.

The yield of vanillic acid from the bicarbonate-soluble fraction was 2.1% (based on chlorite lignin), giving a total yield of 5.3% of vanillic acid from both the bicarbonate- and bisulphite-soluble fractions.

The phenol fraction, after trituration with petroleum ether, yielded 2.6 grams of *p*-hydroxyazobenzene but no products which originated from the chlorite lignin could be isolated.

OXIDATIONS OF VANILLIN, 6-CHLOROVANILLIN, AND VANILLIC ACID

The main products of the alkaline nitrobenzene oxidation of chlorite lignin (vanillin, 6-chlorovanillin, and vanillic acid), were subjected to conditions approximating those used in oxidations 1 through 4 to answer two important questions.

1. How resistant are these compounds to further oxidation and/or degradation once they have been formed from a lignin oxidation? The actual yields may be significantly less than the theoretical values to be obtained if the compounds do not undergo further reaction.

2. To what extent does vanillic acid (or 6-chlorovanillic acid) result from the oxidation of vanillin (or 6-chlorovanillin)?

Oxidation 5, performed on 7.5 grams of vanillin, yielded 75% of unreacted vanillin and slightly less than 1% of vanillic acid. Chromatographic analysis on acid-washed Magnesol, using 100:1 benzene-ethanol as developer, showed a minor zone which gave a strong green color when streaked with ferric chloride solution; this behavior suggested the presence of an ortho-dihydroxy compound such as demethylated vanillin—i.e., protocatechualdehyde. The zone was eluted and examined on a paper chromatogram developed with butanol-aqueous ammonia and sprayed with bis-diazotized benzidine (*12*). In addition to spots corresponding to vanillin and vanillic acid, a spot was found at R_F 0.32, the behavior of which was identical in every way with the spot produced by an authentic sample of protocatechualdehyde.

Oxidation 6, performed on 7.5 grams of 6-chlorovanillin, was similar to the one just described; 6-chlorovanillin was recovered unchanged in a yield of 81%. The corresponding oxidized and demethylated products, vanillic acid and 6-chloroprotocatechualdehyde, were qualitatively identified by their chromatographic behavior.

The demethylation observed in oxidations 5 and 6 is a phenomenon not previously reported for this type of reaction, probably because the separation methods used were less sensitive than chromatographic techniques. In this work, the actual yields of demethylated products, were not determined; however, Zentner (*19*), using chromatographic methods, isolated 2 to 3% of protocatechualdehyde from the reaction of vanillin with a sodium hydrosulphide liquor at a temperature and alkalinity approximating the conditions used in this work.

Vanillic acid was recovered unchanged from oxidation 7 in a yield of 74%. Chromatographic analysis showed the absence of possible demethylated products, such as protocatechuic acid or pyrocatechol; neither was there any evidence of the possible decarboxylated product, guaiacol.

MODIFIED OXIDATION CONDITIONS

Oxidations 8 and 9, each using 7.5 grams of Barton's chlorite lignin A (see Table II for analysis), were performed with slightly modified oxidation conditions to reveal the possible influence of small changes in time and temperature on the yields of vanillin, 6-chlorovanillin, and vanillic acid.

Oxidation 8 was performed under conditions approximating those used by Leopold (*11*), who found that 2 hr. at 180° constituted the optimum conditions for the production of vanillin by the alkaline nitrobenzene oxidation of model compounds.

Oxidation 9 retained Freudenberg's original conditions of 3 hr. at 160°; however, the heating and cooling periods attendant to the oxidation were extended somewhat (see Table III).

Separation techniques were essentially those reported for oxidation 4 with one major variation. The cellulose column with butanol-aqueous ammonia development was used both on the bisuphite-soluble fraction to isolate vanillin and 6-chlorovanillin and on the acid fraction; from the latter fraction was obtained not only vanillic acid but also *p*-phenylazobenzoic acid. This modified nitrobenzene reduction product, not previously report from reactions of this type, was identified by carbon and hydrogen analysis, by mixed melting point, and by comparison of its ultraviolet absorption spectrum with that of an authentic sample. The compound may have been formed by the reaction of carbon dioxide with azobenzene or with a nitrobenzene reduction product which was subsequently reduced. The formation of this carboxysubstituted azobenzene has an interesting analog in the formation of sodium *p*-azobenzenesulphonate during the alkaline nitrobenzene oxidations of kraft or sulphite liquors (*9, 20*).

The yield of *p*-phenylazobenzoic acid was small (184 mg. from 14.6 grams of nitrobenzene) but the compound was readily separated from the vanillic acid on a powdered cellulose column; the former compound moved almost with the butanol-aqueous ammonia developer front, whereas the vanillic acid did not appear in the eluate until approximately 500 ml. of developer had been passed.

Reference to Table III shows that, when the relatively large experimental errors are considered, slight

Table IV. Yields of Major Fractions

Fraction	Yield, %[a] — Oxidation Number 4	8	9
Bisulphite-soluble	25.6	28.4	31.0
Bicarbonate-soluble	7.1	12.0	11.2
Sodium hydroxide-soluble	4.7	5.2	6.1
Neutral	0.9	1.0	4.0
Total	38.3	46.6	52.3

[a] All yields are based on weight of chlorite lignin used as starting material.

modifications in oxidation conditions did not cause any great changes in the yields of the crystalline products; neither was there any significant change in the yields of the major fractions (see Table IV).

In oxidation 6, the acidic aqueous solution remaining after ether extraction of the oxidation products was treated with silver nitrate and the resultant silver chloride precipitate was collected and weighed. It was shown that approximately 5% of the chlorine in 6-chlorovanillin was converted to chloride ion during the oxidation.

A similar treatment of the oxidation products of chlorite lignin in oxidation 9 showed that approximately 25% of the chlorine was converted to chloride ion, indicating that a part of the chlorine in chlorite lignin was considerably more labile than the chlorine in 6-chlorovanillin.

DISCUSSION

The isolation of vanillin, 6-chlorovanillin, and vanillic acid as oxidation products definitely establishes that chlorite lignin is built around the guaiacyl nucleus as is the lignin from which it was derived.

The isolation of 6-chlorovanillin and the absence of any detectable quantity of 5-chlorovanillin substantiates the work of Lautsch and Piazolo (*14*) who found corresponding results with bromolignin. At first consideration, the lack of any evidence for chlorination in the 5-position is surprising, inasmuch as the presence of free phenolic hydroxyl groups in lignin is well established; this group has an ortho-para directing influence and a high activating strength and should induce 5-substitution. However, Barton found the phenolic group to be absent from chlorite lignin. This suggests that the guaiacyl group of lignin which contains the free phenolic hydroxyl group may possibly undergo chlorination in the 5-position during the chloriting reaction but that it is cleaved or degraded from the more resistant portion of the lignin molecule which is later isolated as chlorite lignin.

Another interesting speculation to explain the absence of 5-chlorovanillin lies in the known carbon-to-carbon linkage at the 5-position in a portion of the lignin molecule as evidenced by the isolation of 5-formyl- and 5-carboxy- compounds. Leopold (*12*) believed that as much as one half of the guaiacyl nuclei are so substituted. If the nucleus containing the free phenolic group also contains the carbon-to-carbon linkage at the 5-position, no 5-chloro compound could be formed.

Another interesting result is the difference between the ratio of chlorinated to unchlorinated compounds in the aldehyde and acid fractions; that is, the yields of vanillin and 6-chlorovanillin were of the same order of magnitude, whereas the amount of 6-chlorovanillic acid was insignificant relative to that of vanillic acid. This suggests that structural factors which favor oxidation of the side chain directly to the carboxyl group discourage chlorine substitution or, conversely, the presence of chlorine in the nucleus stabilizes the molecule at the aldehyde stage of side chain oxidation.

Similarities in analytical data and oxidation products strongly suggest that the chlorite lignin preparations of Barton and of Bublitz are very similar to the material isolated by Wacek and Schroth (*5*) despite the differences in isolation technique. Wacek and Schroth found that oxidation of their product yielded more acid than aldehyde. This behavior of chlorite lignin is confirmed by the results found in this work. The amount vanillic acid formed was of the same order of magnitude as the combined yields of vanillin and 6-chlorovanillin. This is to be contrasted with the behavior of wood or other isolated lignins which yield acid and aldehyde in the approximate ratio of 1 to 5. This evidence, with the high carboxyl content of chlorite lignin, clearly shows the partially oxidized character of the preparation.

In view of the small conversion of the formyl group in vanillin to the carboxyl group during oxidation (less than 1%), it may be concluded that a portion of the lignin molecule is susceptible to direct conversion to the carboxyl group; furthermore, the relatively higher yields of vanillic acid from chlorite lignin indicate that chloriting modifies the lignin in such a way as to accentuate this carboxyl group formation. This work uncovered no evidence to prove or disprove the hypothesis that chlorite lignin contains guaiacyl nuclei in which the side chain has been completely oxidized to the carboxyl group.

LITERATURE CITED

1. Sohn, A. W., and Reiff, F., *Papier-Fabr.* 40: 1–7, 105–112 (1942).
2. Jayme, G., and Hanke, G., *Cellulosechem.* 21: 127–140 (1943).
3. Barton, J. S., *Tappi* 33: 496–502 (1950).
4. Bublitz, W. J., "A Study of the Carbohydrate Fraction of Spruce Chlorite Liquors." Doctor's Dissertation. Appleton, Wis., The Institute of Paper Chemistry, 1949. 87 p.
5. Wacek, A. v., and Schroth, D., *Das Papier* 4: 410–414 (1950).
6. Schultz, L., U. S. pat. 2,187,366 (Jan. 16, 1940).
7. Freudenberg, K., Lautsch, W., and Engler, K., *Ber.* 73B: 167–171 (1940).
8. Creighton, R. H. J., McCarthy, J. L., and Hibbert, H., *J. Am. Chem. Soc.* 63: 312 (1941); Creighton, R. H. J., McCarthy, J. L., and Hibbert, H., *J. Am. Chem. Soc.* 63: 3049–3052 (1941); Creighton, R. H. J., Gibbs, R. D., and Hibbert, H., *J. Am. Chem. Soc.* 66: 32–37 (1944); Creighton, R. H. J., and Hibbert, H., *J. Am. Chem. Soc.* 66: 37–38 (1944).
9. Pearl, I. A., and Lewis, H. F., *Ind. Eng. Chem.* 36: 664–669 (1944).
10. Wacek, A. v., and Kratzl, K., *J. Polymer Sci.* 3: 539–548 (1948).
11. Leopold, B., *Acta Chem. Scand.* 4: 1523–1537 (1950).
12. Leopold, B., *Acta Chem. Scand.* 6: 38–48 (1952).
13. Pearl, I. A., *J. Am. Chem. Soc.* 68: 916 (1946).
14. Lautsch, W., and Piazolo, G., *Ber.* 73: 317–320 (1940).
15. Barton, J. S., "A Study of the Reaction Products of Lignin and Sodium Chlorite in Acid Solution." Doctor's Dissertation. Appleton, Wis., The Institute of Paper Chemistry, 1947. 91 p.
16. Raiford, L. C., and Lichty, J. G., *J. Am. Chem. Soc.* 52: 4576–4586 (1930).
17. Pearl, I. A., *J. Org. Chem.* 12: 79–84 (1947).
18. Pearl, I. A., and Dickey, E. E., *J. Am. Chem. Soc.* 73: 863 (1951).
19. Zentner, T. G., *Tappi*, in press.
20. Csellak, W. R., *Tappi* 34: 471–472 (1951).

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ASSOCIATION NEWS AND EVENTS

TAPPI 39th Annual Meeting

The 39th Annual Meeting of the Technical Association of the Pulp and Paper Industry will be held at the Commodore Hotel, New York, N. Y., on Feb. 15–18, 1954.

Members of the Association should remember to bring their 1954 membership cards with them since the lower registration fee will be limited to individuals who can present their 1954 cards. All individuals attending the Annual Meeting must register.

MONDAY, FEBRUARY 15, 1954

10:00 a.m. First General Session (East Ball Room)

G. H. Pringle, President of TAPPI, Mead Corp., Chillicothe, Ohio, *Chairman*

1. Secretary's Report, by R. G. Macdonald.
2. President's Address, by George H. Pringle.
3. Report of the Tellers Committee.
4. Report of the Joint Textbook Committee, by R. S. Kellogg, *Secretary*.
5. "The Paper Industry in the Far East," by Roland A. Packard, Washington, D. C.
6. "Fiberglas as a Papermaking Material," by Thomas S. Chambers, Owens-Corning Fiberglas Co., Newark, Ohio.
7. "Manufacture of Board Continuously by a Dry Process," by R. S. Aries, Aries Fireboard Corp., New York, N. Y.

10:30 a.m. Wax Testing (Room C)

Section I, Strength Tests, J. W. Padgett, *Chairman*

10:00 a.m. Packaging Materials Testing Committee (Room F)

2:00 p.m. Committee Meetings (Grand Ball Room)

All committee meetings will be held in the Grand Ball Room unless otherwise indicated.

Tables assigned to committees will be designated by table cards.

Research Development Division (Grand Ball Room)

W. F. Holzer, Crown Zellerbach Corp., San Francisco, Calif., *General Chairman*

Statistics Committee—John F. Langmaid, Jr., *Chairman*, S. D. Warren Co., Cumberland Mills, Me.
Microbiological Committee—B. F. Shema, *Chairman*, Institute of Paper Chemistry, Appleton, Wis. (Room G, Wed.)
Fundamental Research Committee—H. F. Lewis, *Chairman*, Institute of Paper Chemistry, Appleton, Wis. (Room 825)

Industrial Division (Grand Ball Room)

N. I. Bearse, Champion-International Co., Lawrence, Mass., *General Chairman*

Nonfibrous Raw Materials Committee—E. N. Poor, Hudson Pulp & Paper Co., Augusta, Me., *Chairman*
Water Committee—A. S. Erspamer, St. Helens Pulp & Paper Co., Division, Crown Zellerbach Corp., St. Helens, Ore., *Chairman*
Fibrous Agricultural Residues Committee—S. I. Aronovsky, Northern Regional Research Laboratory, Peoria, Ill., *Chairman*
Structural Fibrous Materials Committee—E. M. Jenkins, Johns-Manville Research Center, Manville, N. J. *Chairman* (Room G, Tues., 2:00 p.m.)

Converting and Consuming Division (East Ball Room)

L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio, *General Chairman*

Graphic Arts—C. A. Morton, West Virginia Pulp & Paper Co., Chicago, Ill., *Chairman*
Coating Committee—R. T. Trelfa, Watervliet Paper Co., Watervliet, Mich., *Chairman*
Wet Strength Committee—K. W. Britt, Scott Paper Co., Chester, Pa., *Chairman*
Plastics Committee—R. T. Nazzaro, Westfield River Paper Co., Russell, Mass., *Chairman*
Corrugated Containers Committee—Burt Mendlin, Cornell Paperboard Products, Milwaukee, Wis., *Chairman*

Pulp Manufacture Division (Grand Ball Room)

G. A. Day, Brown Co., Berlin, N. H., *General Chairman*

Alkaline Pulping Committee—Fred W. Bishop, Southland Paper Mills, Lufkin, Tex., *Chairman*
Mechanical Pulping Committee—F. W. O'Neil, College of Forestry, State University of New York, Syracuse, N. Y., *Chairman*
Chemical Products Committee—Arthur Pollak, Consulting Engineer, New York, N. Y., *Chairman*
Pulp Purification Committee—H. Howard Rapson, University of Toronto, Toronto, Ont., *Chairman*
Acid Pulping Committee—E. H. Woodruff, Rayonier Inc., Port Angeles, Wash., *Chairman*
Semichemical Pulping Committee—J. N. McGovern, Forest Products Laboratory, Madison, Wis., *Chairman*
Paper Deinking Committee—J. J. Forsythe, International Paper Co., Niagara Falls, N. Y., *Chairman*
Pulp for Chemical Conversion—F. A. Simmonds, Forest Products Laboratory, Madison Wis., *Chairman*

Paper Manufacture Division (Grand Ball Room)

R. P. Price, Hammermill Paper Co., Erie, Pa., *General Chairman*

Preparation of Papermaking Materials Committee—F. S. Klein, Byron Weston Co., Dalton, Mass., *Chairman*
Papermaking (Cylinder) Committee—Glen Renegar, Container Corp. of America, Manayunk, Pa., *Chairman* (Room E)
Papermaking (Fourdrinier) Committee—N. R. Phillips, Champion Paper & Fibre Co., Canton, N. C., *Chairman* (Room F)

Testing Division (West Ball Room)

James d'A. Clark, Consultant, Longview, Wash., *General Chairman*

Nonfibrous Materials Testing Committee—J. P. Casey, A. E. Staley Mfg. Co., Decatur, Ill., *Chairman*
Pulp Testing Committee—F. E. Caskey, Crown Zellerbach Corp., Camas, Wash., *Chairman*
Optical Properties Committee—H. E. Obermanns, Hammermill Paper Co., Erie, Pa., *Chairman*
Microscopy Committee—C. E. Brandon, Howard Paper Mills, Dayton, Ohio, *Chairman*
Paper Testing Committee—D. H. Newcomb, Riegel Paper Corp., Hughesville, N. J., *Chairman*
Packaging Materials Testing Committee—W. H. Aiken, Gardner Board & Carton Co., Middletown, Ohio, *Chairman* (Room C 10:00 a.m.)
Chemical Methods—A. S. O'Brien, Eastman Kodak Co., Rochester, N. Y., *Chairman*
Wax Testing—W. J. Yates, Shell Oil Co., New York, N. Y., *Secretary*
(Section II, Flow Tests, and Section III, Stability) Tests (Room C)

Note: Reports by all committee chairmen of the Testing Division will be given at this session.

Engineering Division (Room A)

C. J. Sibler, West Virginia Pulp & Paper Co., New York, N. Y., *General Chairman*

Steam and Power Committee—W. M. Wyburn, Federal Paper Board Co., Bogota, N. J., *Chairman*
Materials Handling Committee—W. R. McNally, Link-Belt Co., Chicago, Ill., *Chairman*
Chemical Engineering Committee—J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga., *Chairman*

Digester Corrosion Subcommittee—N. Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y., *Chairman*
Mill Maintenance Materials Committee—G. F. Hrubecky, Marathon Corp., Menasha, Wis., *Chairman*
Mill Planning and Economics Committee—R. A. Packard, Washington, D. C., *Chairman*
Engineering Research and Machine Design Committee—R. G. Quinn, Johns-Manville Corp., Manville, N. J., *Chairman*
Electrical Engineering Committee—R. W. Foster, Champion Paper & Fibre Co., Canton N. C., *Chairman*
Data Sheets Committee—J. W. Hemphill, Johns-Manville Corp., New York, N. Y., *Chairman*
Drying and Ventilating Committee—C. A. Young, Riegel Paper Corp., Milford, N. J., *Chairman*

TUESDAY, FEBRUARY 16, 1954

9:15 a.m. Corrugated Containers (Grand Ball Room)

Burt Mendlin, Cornell Paperboard Products, *Chairman*

9:15 a.m. Digester Corrosion (East Ball Room)

N. Shoumatoff, West Virginia Pulp & Paper Co., *Chairman*

1. "The History of Carbon Brick Linings in Alkaline Pulping Digesters," by Beaumont Thomas, Stebbins Engineering & Mfg. Co., Watertown, N. Y.
2. "A Laboratory Approach to the Study of Digester Corrosion," by J. W. Hassler, West Virginia Pulp & Paper Co., Tyrone, Pa.
3. "Experiments with Digester Corrosion Variables," by E. W. Hopper and J. M. Morrison, Crucible Steel Co. of America, Pittsburgh, Pa.
4. "Comparative Analysis of Digester Corrosion Measurements" (Summary Report No. 2), by N. Shoumatoff, West Virginia Pulp & Paper Co., and H. O. Teeple, International Nickel Co., New York, N. Y.
5. "Field Investigation of Corrosion in Alkaline Pulping Equipment," by C. B. Christianson, Pulp and Paper Research Institute of Canada, Montreal, P. Q.
6. "Bibliography on Alkaline Digester-Corrosion," by R. P. Whitney, Institute of Paper Chemistry, Appleton, Wis., and S. J. Baisch, Thilmany Pulp & Paper Co., Kaukauna, Wis. (by title).

9:15 a.m. Wax Testing (Room A)

Section IV, Sensory Tests, G. D. Fronmuller, *Chairman*
Section VIII, Scuff and Gloss, G. P. Mueller, *Chairman*

9:15 a.m. Papermaking (Fourdrinier) (Room B-C)

N. R. Phillips, Champion Paper & Fibre Co., *Chairman*

1. "Use of the Tracerlab Mass Per Unit Area Instrument on Newsprint Felt Wear and Wire Wear," by a representative of Southland Paper Mills, Lufkin, Tex.
2. "Load Meters, Tension Meters and Torque Meters for Paper Machines," by John C. Harper, Downington Mfg. Co., Downingtown, Pa.
3. "Use of Television in Paper Mills," by Lyle B. Schueler, Diamond Power Specialty Co., Lancaster, Ohio.
4. "An Experimental Study of the Factors Involved in the Manufacture of Paper Yarn," by Geoffrey Broughton, University of Rochester, Rochester, N. Y., and James P. Wang, Lowell Technological Institute, Lowell, Mass.
5. "The Mechanical Properties of Paper," by Geoffrey Broughton and James P. Wang (by title).
6. "The Interrelation of Fiber Length Distribution, Fiber Length Index, and Physical Characteristics of Handsheets," by A. H. Nadelman, Western Michigan College, Kalamazoo, Mich.
7. "A Laboratory Evaluation of Certain Starches and Natural Gums as Acids in the Papermaking Process," by C. Megan Holder, Water von Drathon, William Hillis, and Merchant L. Cushing, Stein, Hall & Co., New York, N. Y.
8. "An Investigation of Methods for Dimensionally Stabilizing Paper," by Frank Lorey, Mead Corp., Chillicothe, Ohio.

9:15 a.m. Structural Fibrous Materials (South Room)

E. M. Jenkins, Johns-Manville Research Center, *Chairman*

1. "The Importance of Speed of Test on Bending Strength Properties of Insulating Board," by Wayne C. Lewis, Forest Products Laboratory, Madison, Wis.
2. "Evaluation of the TAPPI-SFMC Drainage Time Tester for Mill Control of Insulating Board Pulps," by W. H. Graham, Johns-Manville Products Corp., Natchez, Miss.
3. "A Comparison of the TAPPI-SFMC Drainage Time Test Procedure with Olin Methods," by D. R. P. Haig, Johns-Manville Research Center, Manville, N. J.
4. "Evaluation of the TAPPI-SFMC Drainage Time Tester of TAPPI T 1002 sm-51," by Jules J. Perot, Flintkote Co., Whippany, N. J., and C. E. Hrubesky, Forest Products Laboratory, Madison, Wis.
5. Panel Discussion: J. J. Perot, Moderator, Thure Duval, Wood Conversion Co., Cloquet, Minn., C. E. Hrubesky, and D. R. P. Haig.

9:15 a.m. Papermaking (Cylinder) (West Ball Room)

Glen Renegar, Container Corp. of America, *Chairman*

1. "Smoothness of Paperboard" (a symposium).
   (a) "Scope of the Problem," by G. T. Renegar.
   (b) "End Use Requirements and Testing for Smoothness," by A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.
   (c) "Finishing and Drying," by K. M. Winrich, Cornell Paperboard Products Co., Cornell, Wis., and Peter Smith, Continental Paper Co., Ridgefield Park, N. J.

2:00 p.m. Papermaking (Cylinder) (West Ball Room)

1. "Smoothness of Paperboard" (*continued*).
   (d) "Wet End Aspects," by G. C. Ehemann, Ohio Boxboard Co., Rittman, Ohio.
   (e) "Stock Preparation," by E. F. Manogue, Gibraltar Corrugated Paper Co., North Bergen, N. J.
   (f) "Raw Materials Problems," by A. E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.

2:00 p.m. Structural Fibrous Materials (Room G)

Committee Meeting

2:00 p.m. Acid Pulping (Room B-C)

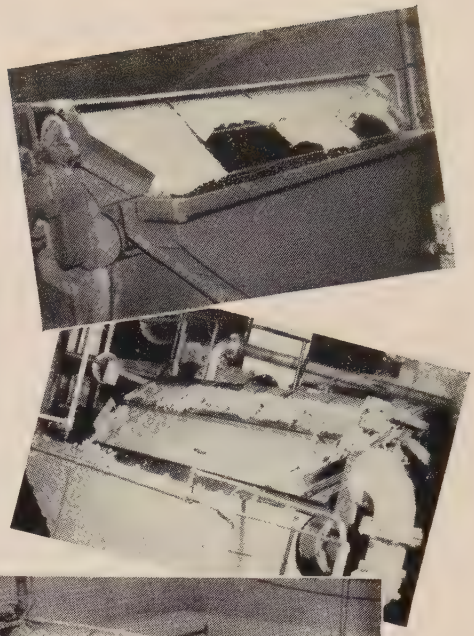
E. H. Woodruff, Rayonier Inc., *Chairman*

1. "The Resistance of Douglas Fir to Sulphite Pulping," by William H. Hoge, Oxford Paper Co., Rumford, Me.
2. Panel on Acid Pulping—G. H. McGregor, Minnesota & Ontario Paper Co., International Falls, Minn., Moderator.
   (a) "Acid Sulphite Pulping with Bases Other Than Calcium," by R. S. Hatch, Hudson Pulp & Paper Co., Palatka, Fla.
   (b) "Acid Sulphite Pulping of Other Than Normal Species, Such as Highly Resinous Woods and Deciduous Woods," by G. H. McGregor.
   (c) "High Yield Acid Sulphite Pulping," by L. R. Beath, Price Bros. & Co. Ltd., Riverbend, P. Q.
   (d) "Sulphite Pulping and Stream Pollution in Eastern U.S.A.," by V. P. Edwardes, Corinth, N. Y.
   (e) "Sulphite Pulping and Stream Problems in the Pacific Northwest." by H. R. Amberg, National Council for Stream Improvement, Corvallis, Ore.
   (f) "Sulphite Pulping and Stream Problems in the Midwest," by N. L. Malcove, Northern Paper Mills, Green Bay, Wis.

2:00 p.m. Corrugated Containers (Grand Ball Room)

Program to be announced.

LOW COST recovery of HIGH COST paper stock



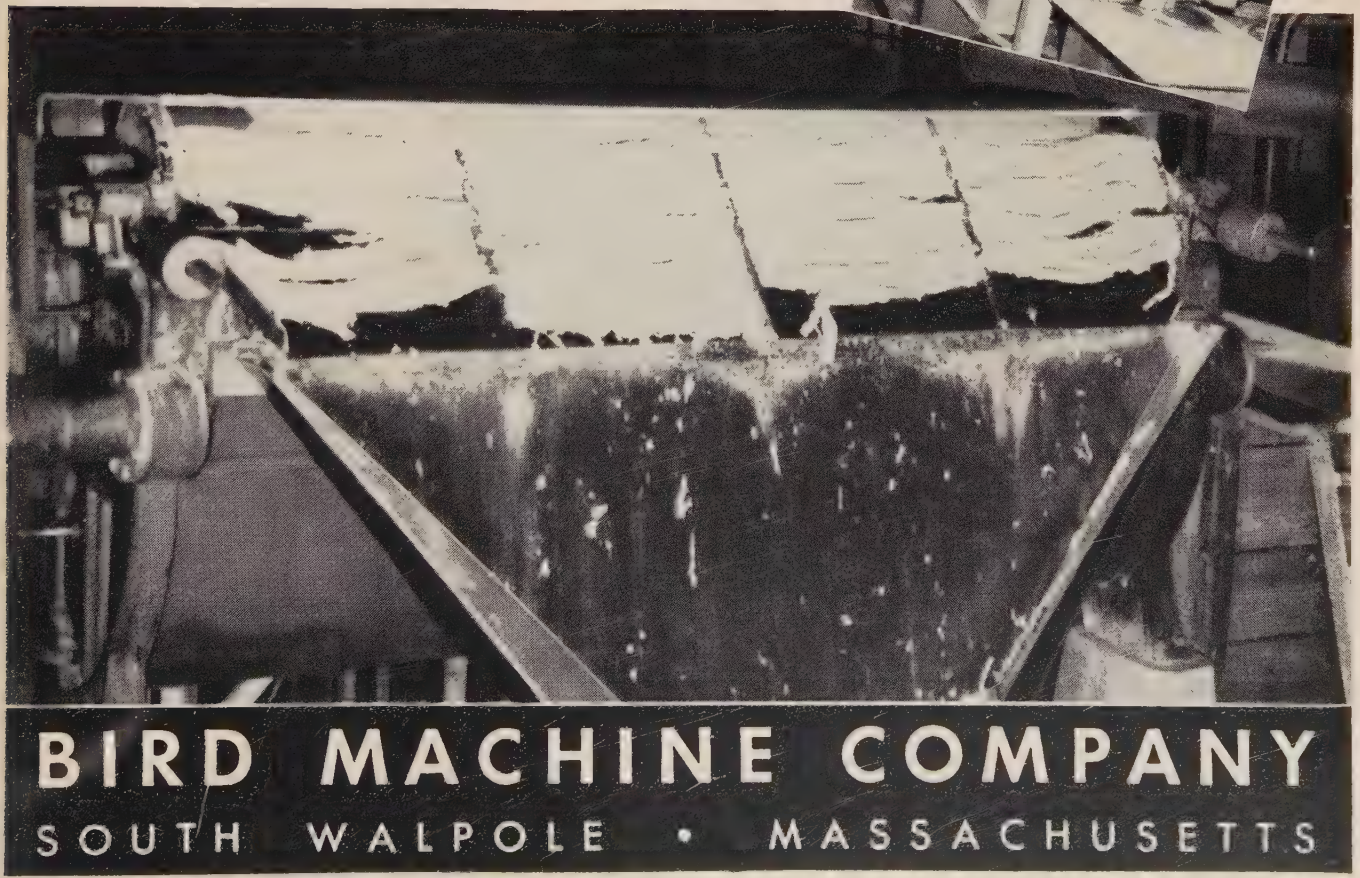
— that's what you're looking at in these pictures of Bird Save-Alls at work.

— and that's what you'd better make sure of in *your* mill

1 by providing enough Save-All capacity to handle your present volume of white water, and

2 by setting up a good, tight up-to-the-minute system that will recover a maximum amount of stock at lowest cost per ton

BIRD SAVE-ALLS



BIRD MACHINE COMPANY

SOUTH WALPOLE • MASSACHUSETTS

2:00 p.m. Papermaking (Fourdrinier) (Room A)

N. R. Phillips, *Chairman*

1. Question and Answer Session on Papermaking.

2:00 p.m. Wax Testing (South Room)

Section V, Composition, J. B. Rather, *Chairman*
Section VI, Blocking, H. F. Hitchcox, *Chairman*

WEDNESDAY, FEBRUARY 17, 1954

9:15 a.m. Corrugated Containers (Grand Ball Room)

Program to be announced.

9:15 a.m. Papermaking (Cylinder) (West Ball Room)

Glen T. Renegar, *Chairman*

1. Review of symposium on "Smoothness of Paperboard," by Glen T. Renegar.
2. Consideration of Cylinder Machine Paper Defects, Lumpy Formation, Felt Marks, Wire Marks, Foreign Matter (Shives, Shivespots), Fuzziness, Interfiber Voids, Cockles, Surface Pick (at Calenders), Check and Crush Mechanical Damages, Compressibility.

9:15 a.m. Pulp Purification (East Ball Room)

W. Howard Rapson, Universiy of Toronto, *Chairman*

1. "A New Process for the Bleaching of Chemical Pulps, Especially Kraft, with Peroxide," by W. F. Schroeder, National Distillers Chemical Corp., Ashtabula, Ohio.
2. "Bleaching with Chlorine Dioxide," by W. D. Harrison, Riegel Paper Corp., Milford, N. J.
3. "Chromatographic Techniques in the Analysis of Purified Pulps," by J. F. Saeman, W. E. Moore, and R. L. Mitchell, Forest Products Laboratory, Madison, Wis.
4. "A Comparison of Processes for Manufacturing Chlorine Dioxide in Pulp Mills," by W. Howard Rapson.

9:15 a.m. Statistics (Room B-C)

John F. Langmaid, Jr., S. D. Warren Co., Cumberland Mills, Me., *Chairman*

Program to be announced

9:15 a.m. Wax Testing (Room A)

Section VII, Sealing and Laminating, G. C. Borden, Jr., *Chairman*

9:15 a.m. Paper Testing and Microscopy (Room F)

9:15 a.m. Testing (South Room)

A. S. O'Brien, Eastman Kodak Co., *Chairman*

1. "The Effect of Copper and Base Concentrations in Cellulose Solvents," by B. L. Browning, Institute of Paper Chemistry, Appleton, Wis.
2. "Prediction of Brightness of Groundwood-Sulphite Mixtures," by D. J. MacLaurin, Institute of Paper Chemistry, Appleton, Wis., and F. A. Aflenzer, Institute of Pulp and Paper Technology, Graz, Austria.
3. "Crystalline and Amorphous Fractions of Cellulose," by Geoffrey Broughton, University of Rochester, Rochester, N. Y.
4. "Photometric Determination of the Solubility of Pulp in Sodium Hydroxide Solutions," by Ralph M. Kingsbury, Forest Products Laboratory, Madison, Wis.
5. "How Retention and Wet Strength are Related to the Cationic Character of Urea-Formaldehyde Wet-Strength Resins," by J. Vernon Kindall, Plaskon Div., Libbey-Owens-Ford Co., Toledo, Ohio.

2:00 p.m. Corrugated Containers (Grand Ball Room)

Program to be announced.

2:00 p.m. Statistics (South Room)

Program to be announced.

2:00 p.m. Papermaking (Cylinder) (West Ball Room)

Glen T. Renegar, *Chairman*

Continuation of the morning program.

2:00 p.m. Semichemical Pulping (East Ball Room)

J. N. McGovern, Forest Products Laboratory, Madison, Wis., *Chairman*

1. "Effect of Cooking Conditions in Neutral Sulphite Pulping of Sweetgum," by J. J. Owen, Jr., E. J. McCue, and R. R. Chase, Union Bag & Paper Corp., Savannah, Ga.
2. "An Orienting Study of the Effect of the Neutral Sulphite Semichemical Cook on the Hemicelluloses of Aspenwood," by David C. Lea, Potlatch Forests, Inc., Lewiston, Idaho.
3. "Report of Subcommittee on Semichemical Pulping Equipment Survey," by J. E. Sapp, Gaylord Container Corp., Bogalusa, La.
4. "Properties of Semichemical Pulps," by E. H. Shriver, Mead Corp., Chillicothe, Ohio.

THURSDAY, FEBRUARY 18, 1954

9:00 a.m. Pulps for Chemical Conversion (Room A)

Forrest A. Simmonds, Forest Products Laboratory, Madison, Wis., *Chairman*

1. "Problems in the Evaluation of the Caustic Absorbency of Pulp Sheets," by R. W. Swinehart and A. T. Maasberg, Dow Chemical Co., Midland, Mich.
2. "A Cellulose Yield Test Overcoming the Inadequacies of the Alpha Test," by Frank R. Charles, Industrial Cellulose Research Ltd., Hawkesbury, Ont.
3. "Investigation of the Haze in Cellulose Acetates Made from Wood Pulps," by Keith E. Bradway, Camp Mfg. Co., Franklin, Va.
4. "Purified Hardwood Pulps for Chemical Conversion. II. Prehydrolysis-Sulphate Pulps from Sweetgum," by F. A. Simmonds, J. S. Martin, and R. M. Kingsbury, Forest Products Laboratory, Madison, Wis.
5. "Carbohydrates in Woods and Pulps by Chromatographic Analysis," by Albert Z. Conner, Hercules Powder Co., Wilmington, Del.
6. "Filterability of Viscose Solutions," by Lloyd M. Cook, The Visking Corp., Chicago, Ill.

9:00 a.m. Water (West Ball Room)

A. S. Erspamer, St. Helens Pulp & Paper Division, *Chairman*

1. "Condensate Corrosion—Its Causes and Prevention," by Seldon K. Adkins and Maurice F. Nielsen, National Aluminate Co., Chicago, Ill.
2. "The Continuous Preparation and Application of Silica Sols in the Paper Industry," by L. L. Klinger, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.
3. "The Accelerated Biological Oxidation of Kraft Mill Effluents," by Fred W. Bishop, Southland Paper Mills, Lufkin, Tex.
4. "Fiber Decomposition in Streams," by Nicholas Lardieri, National Council for Stream Improvement, New York, N. Y.
5. "Stream Pollutional Aspects of Mill Antiseptics," by W. M. Van Horn, Institute of Paper Chemistry, Appleton, Wis.
6. "The Biological Inactivation of Mercurials by Pulps," by B. F. Shema, Institute of Paper Chemistry, Appleton, Wis.

9:00 a.m. Alkaline Pulping and Microbiological (Room B-C)

Fred W. Bishop, Southland Paper Mills, *Chairman*, and B. F. Shema, Institute of Paper Chemistry, *Chairman*

1. "The Effect of Alkaline Pulping on the Lignin of *Eucalyptus regnanse*," by J. W. T. Merewether, Australian Paper Manufacturers, Ltd., Melbourne, Australia.

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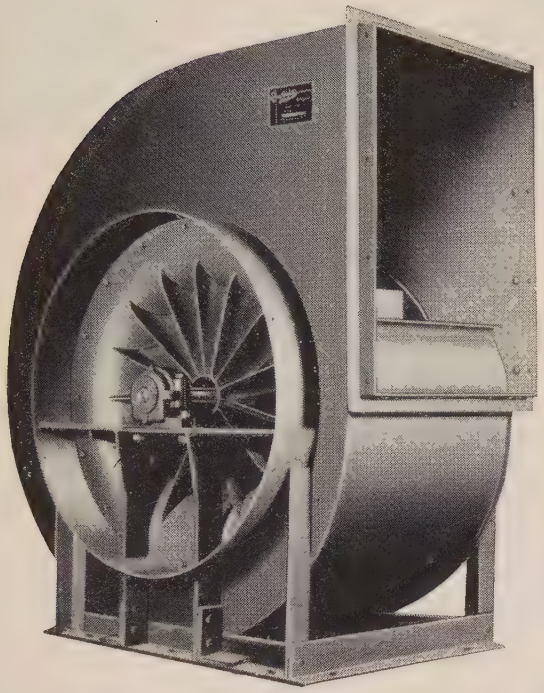

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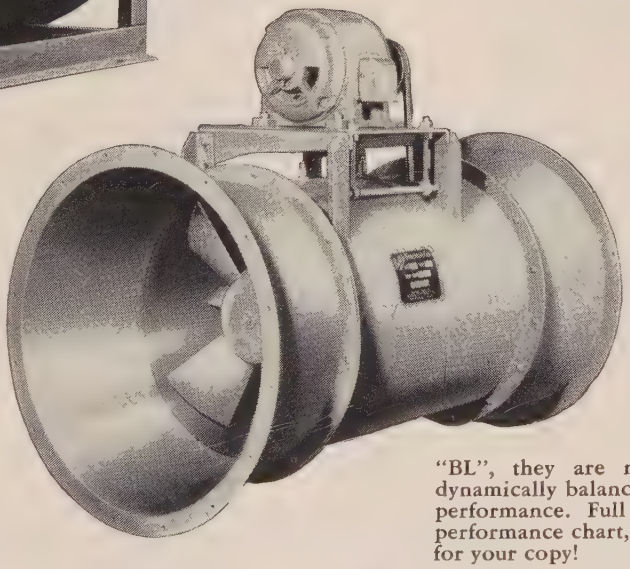

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2. "Lime Sludge Recovery in the Pulp Industry," by W. Tock, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
3. "New Developments in Odor Abatement in Kraft Pulp Mill and Other Related Problems," by Homer M. Rice, E. I. du Pont de Nemours & Co., Inc., Watertown, N. Y.
4. "The Use of the Peabody Scrubber on Lime Kiln Speck Gases," by Paul Mockridge, Peabody Eng. Corp., New York, N. Y.
5. "The Effect of Bark in the Sulphate Pulping of Northern Oak Mixture," by K. I. Brown, Forest Products Laboratory, Madison, Wis.

9:00 a.m. Testing (South Room)

James d'A. Clark, Consultant, Longview, Wash., *Chairman*

1. "The Interrelation of Fiber Length Distribution, Fiber Length Index, and Physical Characteristics of Hand Sheets," by A. H. Nadelman, R. Schmut, D. J. Kraske, and R. I. Larson, Western Michigan College, Kalamazoo, Mich.
2. "The Measurement of Wet Web Strength," by L. M. Lyne and W. Gallay, E. B. Eddy Co., Hull, P. Q.
3. "Studies in the Fundamentals of Wet Web Strength," by L. M. Lyne, and W. Gallay.
4. "The Development and Use of the Chapman Printing Smoothness Tester," by S. M. Chapman, Pulp and Paper Research Institute of Canada, G. R. Sears, Institute of Paper Chemistry, and D. N. Obenshain, West Virginia Pulp & Paper Co.
5. "Development of Method for Measuring the Gloss of Very Glossy Paperboard," by R. S. Hunter, Hunter Associates Laboratory, Falls Church, Va.

1:00 p.m. Annual Luncheon (Grand Ball Room)

1. Address (speaker to be announced).
2. Presentation of the TAPPI Medal to Gunnar W. E. Nicholson, Union Bag & Paper Corp., New York, N. Y., by K. O. Elderkin, Bowaters Southern Paper Corp., Calhoun, Tenn.

The Bleaching of Pulp

Over the years an association such as TAPPI can point to certain milestones of accomplishment. The publication of each new monograph is representative of such milestones. In November, copies of the exceptionally fine TAPPI Monograph No. 10, The Bleaching of Pulp, were distributed to the entire membership.

Because of the high cost of publishing a bound volume of its size (364 pages) it was first decided by the Executive Committee to distribute copies only to members who might request them. A very large number of members made their request for copies on the forms supplied for the purpose. On further consideration, the Executive Committee decided to issue copies to all members because they should be, or may at some time in the future, become interested in some aspects of the contents of the book.

A major problem of the Association in almost any project is to find a member who is willing to undertake the responsibility of carrying on the tedious and voluminous work required to bring the project to fruition. To Ward D. Harrison, vice-president of the Riegel Paper Corp., must go the credit of undertaking the task of having a Pulp Bleaching Monograph written and published. Ward accepted the chairmanship of the TAPPI Pulp Purification Committee with the understanding that the one and only objective of the committee would be to bring out the present monograph. Upon completion of this work all members of the committee resigned as committeemen and a new committee with new personnel was organized to undertake new committee projects.

Chapter authors of The Bleaching of Pulp include: Sidney D. Wells, Institute of Paper Chemistry (Historical Review); R. S. Hatch, Hudson Pulp & Paper Co. (Chlorination, Hypochlorite Bleaching, Special Bleaching Agents, and the Washing of Pulp); Alexander Meller, Australian Paper Manufacturers, Ltd. (Alkaline Extraction of Wood Pulps); W. D. Harrison (Bleaching with Chlorine Dioxide); J. N. Swartz, Howard Smith Paper Mills (Bleaching of Alkaline Cooked Pulps); K. G. Booth, Crown Zellerbach Corp. (Bleaching of Sulphite Pulp); F. A. Simmonds and R. M. Kingsbury, Forest Products Laboratory (Bleaching Semichemical Pulp); L. A. Moss, Whiting-Plover Paper Co. (Bleaching of Rags and Raw Cotton); M. W. Phelps, Peter J. Schweitzer, Inc. (Bleaching of Flax Pulp); Lyman A. Beeman, Finch, Pruyn & Co., and J. S. Reichert, E. I. du Pont de Nemours & Co., Inc. (Peroxides in Pulp Bleaching Processes); T. A. Pascoe, Nekoosa-Edwards Paper Co. (Equipment and Materials of Construction for Bleaching and Pulp Purification); and M. G. Lyon, Champion Paper & Fibre Co. (Bleaching Control and Testing Methods).

Local Section Meetings

Pacific: West Linn, Ore., March 19, 1954. Annual Shibley Award Competition.

Lake States: Conway Hotel, Appleton, Wis., Jan. 12, 1954 Panel Discussion on "Refining," Reinhold A. Vogt, Combined Locks Paper Co., Moderator.

Delaware Valley: Engineers Club, Philadelphia, Pa., Jan. 28, 1954. "Semichemical Pulping."

Kalamazoo Valley: Harris Hotel, Kalamazoo, Mich., Jan. 7, 1954. Joint meeting with the Michigan Division of the Superintendents Association.

Ohio: American Legion Hall, Middletown, Ohio, Jan. 12, 1954. "Statistical Quality Control," by B. E. Sooey, Gardner Board & Carton Co.

Empire State—Metropolitan District: Fraunces Tavern, New York, N. Y., Jan. 12, 1954.

Empire State—Northern District: Martinas Restaurant, Watertown, N. Y., Jan. 14, 1954. Paper by Wilfred Galley, E. B. Eddy Co., Hull, P. Q

Empire State—Central District: University Club, Syracuse, N. Y., Jan. 8, 1954. "The Relation of Paper Quality to Corrugated Board Sales," by W J. Trimble, Robert Gair Co., Syracuse, N. Y.

Empire State—Eastern District: Glens Falls, N. Y., Jan. 21, 1954. "Routine Control Methods."

Empire State—Western District: Prospect House, Niagara Falls, N. Y., Feb. 3, 1954. "High Density Super Bleaching of Chemical Pulps," by F. R. Sheldon and I. C. Gregor, Buffalo Electro-Chemical Co., Buffalo, N. Y.

Lake Erie: Carter Hotel, Cleveland, Ohio, Jan. 15, 1954. "Human Relations."

Southeastern: Hotel Dempsey, Macon, Ga.

British Technical Section

The Sixty-Seventh General Conference of the Technical Section of the British Paper and Board Makers' Association will be held in London, England, on March 24–25, 1954. The theme of the conference will be the technical aspects of the uses of paper, particularly in buying and selling. Special consideration will be given to printing, packaging, stationery, and paper testing.

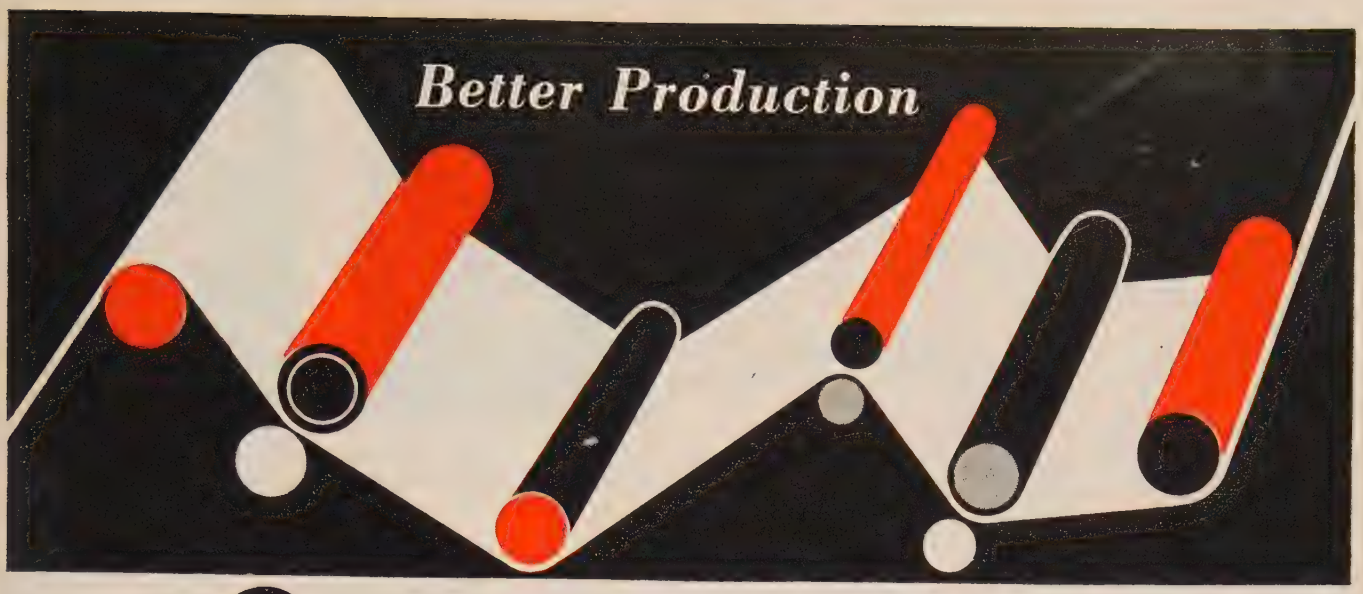
Canadian Annual Meeting

The annual meeting of the Technical Section of the Canadian Pulp and Paper Association will be held at the Sheraton-Mt. Royal Hotel, Montreal, P. Q., on Jan. 27–29, 1954.

The Summer meeting will be held at the Empress Hotel, Victoria, B. C., on June 14–17, 1954.

Engineering Division

At the 8th TAPPI Engineering Conference held at the Sheraton-Mt. Royal Hotel, Montreal, P. Q., on Oct. 26–29,



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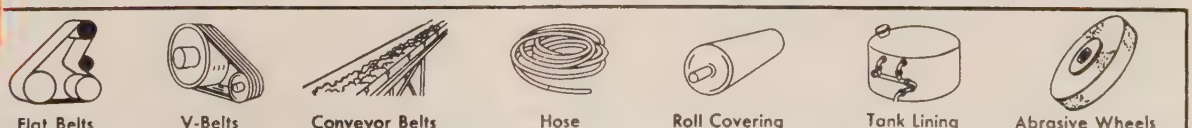

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1953, the following organization of the Division was established:

General Chairman—Charles J. Sibler, West Virginia Pulp & Paper Co., New York, N. Y.
Assistant General Chairman—John D. Lyall, Armstrong Cork Co., Lancaster, Pa.
General Secretary—Walter C. Bloomquist, General Electric Co., Schenectady, N. Y.
Chemical Engineering Committee:
Chairman—J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga.
Secretary—H. O. Teeple, International Nickel Co., New York, N. Y.
Chairman—Digester Corrosion Subcommittee—Nicholas Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y.
Data Sheets Committee:
Chairman—J. W. Hemphill, Johns-Manville Corp., New York, N. Y.
Drying and Ventilating Committee:
Chairman—Curt A. Young, Riegel Paper Corp., Milford, N. J.
Secretary—R. M. Cook, Midwest-Fulton Machine Co., Dayton, Ohio.
Electrical Engineering Committee:
Chairman—Ray W. Foster, Champion Paper & Fibre Co., Canton, N. C.
Secretary—F. J. L. Van Nort, Reliance Electric & Engineering Co., Cleveland, Ohio.
Engineering Research and Machine Design Committee:
Chairman—Robert G. Quinn, Johns-Manville Corp., Manville, N. J.
Secretary—R. D. Irwin, Minneapolis-Honeywell Regulator Co., Brown Instrument Co. Div., Philadelphia, Pa.
Hydraulics Committee:
Chairman—Kenneth J. Mackenzie, Eastman Kodak Co., Rochester, N. Y.
Materials Handling Committee:
Chairman—W. R. McNally, Link-Belt Co., Chicago, Ill.
Secretary—H. A. Stoess, Jr., Fuller Co., Catasauqua, Pa.
Planning and Economics Committee:
Chairman—Roland A. Packard, Takoma Park, Md.
Secretary—P. A. Forni, Mohawk Paper Mills, Cohoes, N. Y.
Mill Maintenance and Materials Committee:
Chairman—George F. Hrubecky, Marathon Corp., Menasha, Wis.
Secretary—A. M. Cooper, Westinghouse Electric Corp., East Pittsburgh, Pa.
Steam and Power Committee:
Chairman—W. M. Wyburn, Federal Paper Board Co., Inc., Bogota, N. J.
Secretary—J. Gottlieb, Westinghouse Electric Corp., New York, N. Y.

Eighth TAPPI Engineering Conference

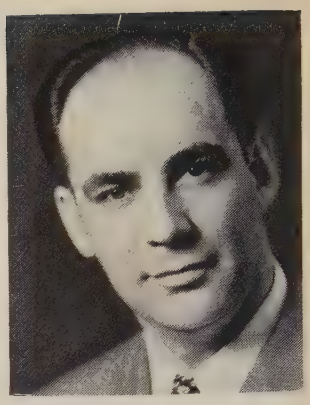
The Eighth Engineering Conference of the Technical Assocation of the Pulp and Paper Industry was held at the Sheraton-Mt. Royal Hotel, Montreal, Que., on Oct. 26–29, 1953. The meeting was opened by the general chairman of the Engineering Division, C. J. Sibler of West Virginia Pulp & Paper Co., who outlined plans for the conference and mill visits to follow.

The first three days of the meeting were devoted to technical sessions, committee luncheons, and discusson meetings, and on the last day delegates visited the plants of Dominion Engineering Works, Ltd. and Dominion Bridge Co., Ltd. at Lachine, just outside Montreal.

During the nine technical sessions, 21 papers were presented covering many aspects of pulp and paper engineering, including hydraulics, machine design, electrical engineering, drying and ventilating, materials handling, mill maintenance, digester corrosion, mill design, and steam and power. A luncheon meeting was held by each of the 10 committees comprising the Engineering Division. In addition, 12 discussion meetings were held, many of them being initiated by informal technical papers.

On Tuesday evening, October 27, delegates were entertained at a reception given by Canadian pulp and paper mills, equipment manufacturers, and suppliers. Following the reception was the official dinner, presided over by C. J. Sibler, who said during his remarks:

C. J. Sibler, West Virginia Pulp & Paper Co.; General Chairman, Engineering Division



W. C. Bloomquist, General Electric Co.; General Secretary, Engineering Division

"It gives me indeed great pleasure to welcome you in the name of the Engineering Division of TAPPI and hope that everyone will have an enjoyable evening. We had a good start through the generosity of our Canadian neighbors and friends who sponsored the cocktail party. Their efforts have made our stay here in this friendly city of Montreal an event long to be remembered. While there had been some hesitancy about going beyond the borders of the United States to hold our annual convention, the record number in our attendance proves that we had made a wise choice.

"Our thanks go to all the sponsors, and in particular to the members of the Canadian Sponsors Committee. Much planning and effort is required to prepare such a meeting and all of you have devoted much of your valuable time and energy in our behalf.

"Words do not express sufficiently our heartfelt appreciation for what you have done for us. We know that the feeling and satisfaction of having a job well done means more to you than anything we could say."

Mr. Sibler introduced the members of the Canadian Local Conference Committee, who were responsible for the planning and preparation of the conference. Chairman of the local committee was A. T. Hurter of Stadler, Hurter, and Co. Secretary of the committee was A. M. Hurter of the same firm. Social arrangements were carried out by T. M. Kettles of Canadian Stebbins Engineering and Mfg. Co., and G. L. M. Hellstrom, Paper Machinery, Ltd. The mill visits were handled by F. S. MacDonald, Hornad Serv. Ltd., A. T. Sutherland, Canadian Vickers, Ltd., and H. E. Cunningham, Dominion Engineering Works, Ltd. J. Newell Stephenson, editor of the *Pulp and Paper Magazine of Canada*, was in charge of publicity.

Mr. Stephenson introduced the speaker of the evening, B. K. Sandwell, dean of Canadian editors. In a highly entertaining and provocative address, Mr. Sandwell discussed Canada's position in the North American economy. United States industrialists, he urged, must accept the fact that, in order to stimulate trade with other countries, the United States will have to accept more goods in an advanced state of manufacture, and not insist that only raw materials or partly manufactured items be imported.

On Wednesday, October 28, Mr. Sibler presided at the Engineering Division luncheon. Commenting on the work of the Engineering Division, Mr. Sibler said:

"We are happy and proud to have so many of you take part in our Eighth Annual Conference of the Engineering Division of TAPPI. Since this Division was originated and held its first meeting at Milwaukee under the leadership of such foresighted men as Gunnar Nicholson, Bumps Hemphill, R. G. Macdonald, and others, the interest in our activities has grown steadily until we reached at this meeting a record registration of 525. More and more it is recognized that the engineering profession plays an important part in the development of the pulp and paper industry. As a matter of fact, we had the job of spending tremendous amounts of money in recent years for modernization and expansion. All these expenditures have to be based on careful planning, engineering, designing, and construction to keep pace

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"I like to think of our activities as something more than just a job. The responsibility placed on us calls for efforts that can not be gaged by a seven-hour day. Continuous special efforts, planning, and ingenuity are required to do our job well. Experience and sound judgment are of greatest importance. This is why we assemble at these meetings so that we may exchange progressive ideas, and profit by our fellow-members' progressive thinking. The great number of engineers assembled here proves to me that management fully recognizes and appreciates the efforts made by our organization.

"Notwithstanding the fact that as a rule engineers are pretty busy people, the ten committees comprising the Engineering Division have offered to you for this meeting a well-rounded program. A total of 21 papers are being presented as well as numerous round-table discussions. It will also please you to know that the Engineering Division has completed its first monograph on digester inspection to be issued early next year. A group of our members best qualified in this field have combined their efforts during the past year and you will be well pleased with the results.

"Our appreciation goes to all those that have contributed in one way or another to the program. My personal thanks go to Mr. Macdonald, the secretary-treasurer of TAPPI, and Walter Bloomquist, general secretary of the Engineering Division. Both have been untiring in their efforts. Credit for the smooth performance of our program goes primarily to these two gentlemen. This is not an easy job when we consider that our organization is operating on a national basis with very little personal contact except during the October and the February conventions.

"And what are our plans for the future? While we have ten active committees with numerous subcommittees covering the various phases of engineering as required by our industry, I feel that we can and should broaden our horizon and include other activities. One field I have in mind in particular is that of river and air pollution. It is the engineer's job to design the plants so that nuisances are reduced to a minimum, and also to find ways and means to correct existing conditions by means of engineering and designing the necessary disposal plants and equipment. This subject becomes of greater importance every day as Federal, State, and Municipal Governments apply and enforce new laws and regulations. I am confident that there are many in our engineering organization that can and will take an active part in our endeavors. Those that want to help in this particular work should write to our Secretary, Mr. Macdonald, who will forward the names to the proper committee.

"Our efforts in this direction are particularly timely as many well-meaning but sometimes not too well-informed organizations are applying great pressure on both the pubic and the legislatures. To show you how some of these efforts can go wrong, I would like to read with your permission a report from the Miami *Daily News*.

" 'Good morning. *Woman's Home Companion.*'

" 'Hello. This is Don Petit of the Miami *Daily News*. I want to talk to the editor.'

" 'One moment, please.'

" 'Good morning, this is Rosellen Callahan.'

" 'Miami demands a retraction.'

" 'I beg pardon.'

" 'A retraction. We want a retraction. Your writer says in an article in your October issue that Miami has polluted air.'

" 'Do you mean the article "Are You Breathing Danger?" by Beatrice Schapper?'

" 'That's the one. That's the one. Where did you get your information anyhow?'

" 'We made a scientific study.'

" 'A what?'

" 'A scientific study. You know we sent questionnaires out to 70 cities and asked them what they are doing to guard against polluted air.'

" 'What didn't we do? How come we're rated "poor" and Pittsburgh is rated "good?" '

" 'Because Pittsburgh is doing something about those smokestacks that belch out that contagious air all over town.'

" 'We ain't got no smokestacks.'

" 'That doesn't make any difference. The answer to the question was "no" that Miami wasn't doing anything about smokestacks so we took points off for that.'

" 'But we ain't got no smokestacks.'

" 'That doesn't make any difference. We didn't go by how much smoke you got but what you're doing about it.'

" 'But we ain't got no smoke. Except maybe for the Neubo Dominicano last week.

" 'We also had to take points off on another question Miami answered "no." We asked "Do your local civic groups actively demand effective air-pollution controls?" and Miami answered "no." '

" 'But there's nothing to demand. We've got no pollution to control.'

A group visiting the Dominion Engineering Works Ltd., Montreal, Que.

" 'That's beside the point. We had to take points off for that, too.'

" 'Oh.'

" 'How about your chimneys down there? Do you control the smoke coming out of them?'

" 'Our what?'

" 'Chimneys. You know, house chimneys. Smoke comes out of them.'

" 'Oh those. I think there're a couple around town someplace. We burn fuel oil down here. No smoke you know.'

" 'That's beside the point. We had to take points off. Miami isn't doing anything about controlling the smoke coming out of the chimneys, according to the answers.

" 'Oh.'

" 'Do your local laws control smoke and fumes from public buildings?'

" 'Well, no. You see we don't have any buildings where smoke and fumes. . . .'

" 'Now, now. We had to take points off for that.'

"(Brightly) 'Wait a minute. We've got a law against smoking cigarets on busses. Can we get credit for that?'

" 'No. We didn't ask that question.'.

"There is no question that our industry does not have a clean record, where river and air pollution are concerned, and we hope this new committee or subcommittee will help those concerned with these problems."

Mr. Sibler introduced Douglas W. Ambridge, president of the Abitibi Power and Paper Co., Toronto, Ont., who addressed the delegates on "The Urgent Needs of the Industry." Text of Mr. Ambridge's address was published in the November issue of *Tappi*. Mr. Sibler's closing remarks were as follows:

"Looking into the future, I would like to advise you that plans are being made to hold our next engineering conference in the Fall of 1954 in the brotherly city of Philadelphia.

"And now in closing, to all of you who attended this convention: It would not be a success without your cooperation and your taking an active part in our meetings and discussions. Keep up the good work by sending in suggestions to the various committees for future projects and talks, or still better, join the committees and take part in their activities. Future success will depend on your willingness to help.

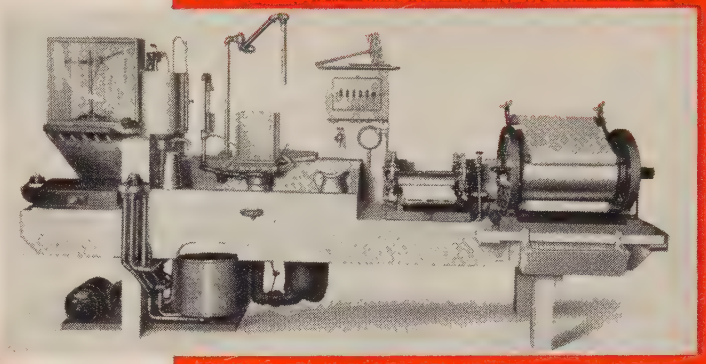
"While we are continuing with our meeting this afternoon and plant visits tomorrow, this is the last opportunity we have to thank our hosts for their wonderful cooperation in making this a successful, long to be remembered convention. Expressing the feelings of all of us, to the sponsors and members of the sponsors' committee, the speakers, Dominion Bridge and Dominion Engineering, and all other companies who have provided opportunities for plant visits, goes our expression of gratitute for the splendid job you accomplished. When our task is finished, we will take back home with us fond memories of this great hospitable city of Montreal, our most cooperative and most generous hosts, and a new evaluation of our great friend and neighbor of the north. Good-bye, or shall we better say, 'au revoir.' "

On Wednesday evening a dinner meeting of committee chairmen and secretaries was proffered by Johns-Manville

Abbe Engineering Co., Brooklyn, N. Y.
Abitibi Power & Paper Co., Sault Ste. Marie, Ont.
Aetna Paper Co., Dayton, Ohio
American Tobacco Co., Richmond, Va.
Amtorg Trading Corp., New York, N. Y.
A.P.W. Paper Co., Albany, N. Y.
Armstrong Cork Co., Lancaster, Pa.
Ball Brothers Co., Noblesville, Ind.
The Barrett Division, Research Laboratory, Edgewater, N. J.
Beach & Arthur Paper Co., Modena, Pa.
Bird & Son, East Walpole, Mass.
Brazilian Government Laboratory, Rio de Janeiro, Brazil
Brooklyn Technical High School, Brooklyn, N. Y.
Brown Company, Berlin, N. H.
Bryant Paper Co., Kalamazoo, Mich.
Casein Co. of America, Bainbridge, N. Y.
Certain-teed Products Co., Chicago, Ill.
Champion International Co., Lawrence, Mass.
Champion Paper & Fibre Co., (2) Canton, N. C.
Champion Paper & Fibre Co., (3) Hamilton, Ohio
Champion Paper & Fibre Co., Pasadena, Tex.
The Columbia Mills, Inc., Syracuse, N. Y.
Columbia Southern Chemical Corp., Barberton, Ohio
Compania de Cellulosa de Filipinas, Manila, Philippine Islands
Continental Can Co., Hopewell, Va.
Continental-Diamond Fibre Co., Bridgeport, Pa.
Consolidated Dyestuff Corp., Montreal, Quebec, Canada
Consolidated Machine & Tool Co., Rochester, N. Y.
Detroit Gasket & Manufacturing Co., Detroit, Mich.
Dixie Cup Company, Easton, Pa.
Douglas Fir Plywood Association, Tacoma, Wash.
E. I. Dupont de Nemours & Co., Deepwater Point, N. J.
E. I. Dupont de Nemours & Co., Newark, N. J.
E. I. Dupont de Nemours & Co., Newport, Del.
E. I. Dupont Experiment Station, Wilmington, Del.
Eastman Kodak Co., Rochester, N. Y.
Ecusta Paper Co., Pisgah Forest, N. C.

Fibreboard Products, Inc., Antioch, Calif.
Finch, Pruyn & Co., Glens Falls, N. Y.
The Gardner Board & Carton Co., Middletown, Ohio
General Chemical Co., Edgewater, N. J.
Gilman Paper Co., Gilman, Vt.
B. F. Goodrich Chemical Co., Akron, Ohio
Great Lakes Paper Co., Fort William, Ont.
Great Northern Paper Co., Millinocket, Me.
Halifax Pulp & Paper Co., Ltd., Nova Scotia
Hawaiian Sugar Planters Association, Honolulu 14, Hawaii
Hawley Pulp & Paper Co., Oregon City, Ore.
Hercules Powder Co., Wilmington, Del.
Hercules Powder Co., Kalamazoo, Mich.
Hercules Powder Co., Holyoke, Mass.
Herty Foundation Laboratory, Savannah, Ga.
Hudson Pulp & Paper Co., Palatka, Fla.
Institute of Paper Chemistry, Appleton, Wis.
Judson College, Rangoon, Burma
Kalamazoo Technical Paper College, Kalamazoo, Mich.
Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.
Kalamazoo Vegetable Parchment Co., Espanola, Ont.
Keyes Fibre Co., Waterville, Maine
Kinsley Chemical Co., Cleveland, Ohio
Laval Universite, Quebec City, Que.
Libbey-Owens-Ford Glass Co., Toledo, Ohio
Longview Fibre Co., Longview, Wash.
Lowe Paper Co., Ridgefield, N. J.
Lowell Textile Institute, Lowell, Mass.
Marathon Corp., Oswego, N. Y.
Massachusetts Institute of Technology, Cambridge, Mass.
The Mead Corporation, Chillicothe, Ohio
Merrimac Chemical Co., Boston, Mass.
Merrimac Paper Co., Lawrence, Mass.
Monadnock Paper Mills, Inc., Bennington, N. H.
Monroe Paper Products Co., Monroe, Mich.
Monsanto Chemical Co., (2) Boston, Mass.
Moraine Paper Co., West Carrollton, Ohio

PARTIAL LIST OF INSTALLATIONS OF
NOBLE & WOOD
Laboratory Sheet Machines
CONTROL ☆ RESEARCH ☆ TESTING



PRODUCES SAMPLE HAND SHEETS OF PAPER 8 INCHES SQUARE FOR TEST PURPOSES

National Newsprint & Paper Mill, Chandi, C. P. India
Naugatuck Chemical Div., Naugatuck, Conn.
New York & Pennsylvania Co., Lock Haven, Pa.
Nueva Papelera Cubana S. A., Havana, Cuba
Ontario & Minnesota Pulp & Paper Co., Ltd., Kenora, Ont.
Oxford Paper Co., Rumford, Maine
Papeteries de Mauduit, Quimperle, France
Paraffine Companies, Emeryville, Calif.
Primera Papelera Cubana S. A., Havana, Cuba
Provincial School of Papermaking, Three Rivers, Que.
Reichhold Chemicals Co., Inc., Royal Oak, Mich.
Richmond Pulp & Paper Co. of Canada, Ltd., Bromptonville, Que.
R. J. Reynolds Tobacco Co. (2), Winston Salem, N. C.
Rohm & Haas Company, Philadelphia, Pa.
Scott Paper Co., Chester, Pa.
P. J. Schweitzer Co., Elizabeth, N. J.
Lic. Neguib Simon, Mexico City, Mex.
Stein, Hall & Co., Inc., New York, N. Y.
J. Strange Paper Co., Menasha, Wis.
St. Helens Pulp & Paper Co., St. Helens, Oregon
St. Regis Paper Co., Deferiet Mill, Carthage, N. Y.
Smith Paper Co., Lee, Mass.
Stilley Plywood Co., Inc., Conway, S. C.
Howard Smith Paper Mills, Cornwall, Ont.
Southland Paper Mills, Inc., Lufkin, Tex.
Sorg Paper Co., Middletown, Ohio
Stevens & Thompson Paper Co., Greenwich, N. Y.
Stillwater Tissue Mills, Stillwater, N. Y.
Technopromimport, (2) Moscow, U.S.S.R.
Testing Machines, Inc., New York City
University of Nebraska, Lincoln, Neb.
University of Missouri, Columbia, Mo.
U. S. Army Chemical Center, Edgewood, Maryland
U. S. Government, Quartermaster Depot, Philadelphia, Pa.
S. D. Warren Co. (2), Cumberland Mills, Me.
Weston Paper & Mfg. Co., St. Marys, Ohio
Wood Flong Corp., Hoosick Falls, N. Y.

THE NOBLE & WOOD MACHINE CO.
Paper Mill Machinery
HOOSICK FALLS • NEW YORK • U.S.A.
Mid-West: Ronningen Engineering Sales • Vicksburg, Mich
West Coast Dan E. Charles Agency • Jones Bldg. • Seattle 1, Wash.

J. D. Lyall, Armstrong Cork Co.

R. E. Durst, University of Maine

Corp., and arranged by J. W. Hemphill, chairman of the Data Sheets Committee and past general chairman of the Engineering Division. Reports were made by all committee chairmen and plans made for next year's Engineering Conference.

The last day of the conference, Thursday, October 29, was devoted to plant visits to the shops of Dominion Engineering Works and Dominion Bridge Co., of Lachine, Que. These two firms provided busses to pick up the delegates at the hotel and take them to Lachine, where they were escorted on a day-long tour of the huge fabricating shops that cover 103 acres on the outskirts of Montreal.

The delegates obtained an excellent picture of Canada's industrial development by observing the equipment under fabrication in various parts of the shops. A few of the items seen were a stainless steel runner for the Kitimat power development of the Aluminum Co. of Canada, digesters, refiners, and reactors for the fast-growing oil industry in the west, sections of the mile-long Halifax-Dartmouth bridge, and many different pieces of paper mill equipment for all parts of Canada. In addition, turbines for New Zealand and Brazil, power shovels for Pakistan, and diesel engines for many different countries were under construction. Dominion Bridge's stress-relieving furnace, 19 ft. square and 75 ft. long, is the largest of its kind in Canada.

The two companies entertained the delegates at a delicious buffet luncheon on the premises of the Dominion Bridge Co. When the tours were completed in the afternoon, busses returned the visitors to their hotel.

A brief résumé of the papers presented during the conference is given below. The full text of all papers presented will be published in forthcoming issues of *Tappi*.

"The Mechanics of Stress and Strain Occurring in a Fourdrinier Wire," by John D. Lyall, Armstrong Cork Co.

The life of fourdrinier wire is dependent upon a great many factors, but the only one directly under the control of the engineer is the range of stress which must be endured by the metal in the wire. The wire is subject to two loadings—tension and bending—and the total stress at any point is the algebraic sum of the stresses produced by these loads. The stress range is the difference in total stress between any two points around the fourdrinier. Methods are presented for calculating the stresses based upon experimental work carried out on a model equipped with electric strain gages. A review of fatigue and fracture data establishes the endurance limit of phosphor-bronze as 54,000 p.s.i. Thus a means is provided to analyze wire runs and to determine precisely the optimum size of roll required at each point in the fourdrinier to satisfy the needs of the wire. The effect of changes in the wire specification can be predicted; and with a better understanding of the mechanics of the wire, less costly and more satisfactory machines can be designed.

"Grounded vs. Ungrounded Power Systems," by G. P. Hobbs, Bowater's Newfoundland Pulp and Paper Mills, Ltd., and R. H. Kaufman, General Electric Co.

Of the electrical machine shutdowns in the paper industry, many are the result of insulation failure in motors or connected circuits. Abnormal voltage stress is frequently a contributing factor and most certainly is in the case of simultaneous multiple failures.

Electrical insulation is very susceptible to deterioration by excess voltage stress. Investigations conducted mainly by Mr. Montsinger indicate that solid insulation (Class A) is subject to a 10-fold reduction in the time to electrical breakdown each time the voltage is increased by one third. When viewed in the light of the wet conditions prevailing in the paper industry, the importance of avoiding unnecessary overvoltages is fully apparent.

Electrical systems, if ungrounded, are subject to damaging overvoltages reaching magnitudes of three times normal or more. Repeated or prolonged application of such voltage stresses promotes premature failure of insulation. There is the element of chain reaction in this process. The voltage effects associated with one fault disturbance become responsible for creating the next fault condition at an early date.

Effective neutral grounding of power distribution systems (solid grounding 600 v. and below, resistance grounding above 600 v.) acts to markedly reduce not only the magnitude but duration of these overvoltage stresses. This indicates that system grounding should result in tremendously increasing insulation life which would be reflected in fewer outages and less down time.

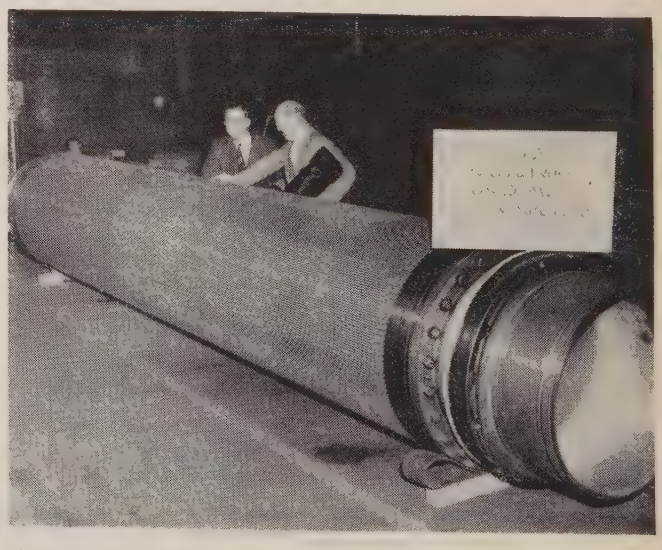
The proof of the pudding is, of course, in the eating. These predicted benefits by system grounding have been proved. Actual service experience has been accumulated which substantiates the following claimed benefits for grounded operation.

1. Eliminates much maintenance time previously spent in fruitless search for system grounds.
2. Eliminates multiple equipment failures which result from excessive overvoltages.
3. Reduces the machine outage rate and down time due to the marked reduction in magnitude and duration of moderate overvoltages.

The benefits to be gained in the paper industry are accentuated because of the adverse effect of water on electrical insulation.

"Progress Report on Pipe Friction Studies," by Richard E. Durst, University of Maine

The suspension flow system at the University of Maine has



A 44-in. suction couch roll for a 226-in. newsprint machine

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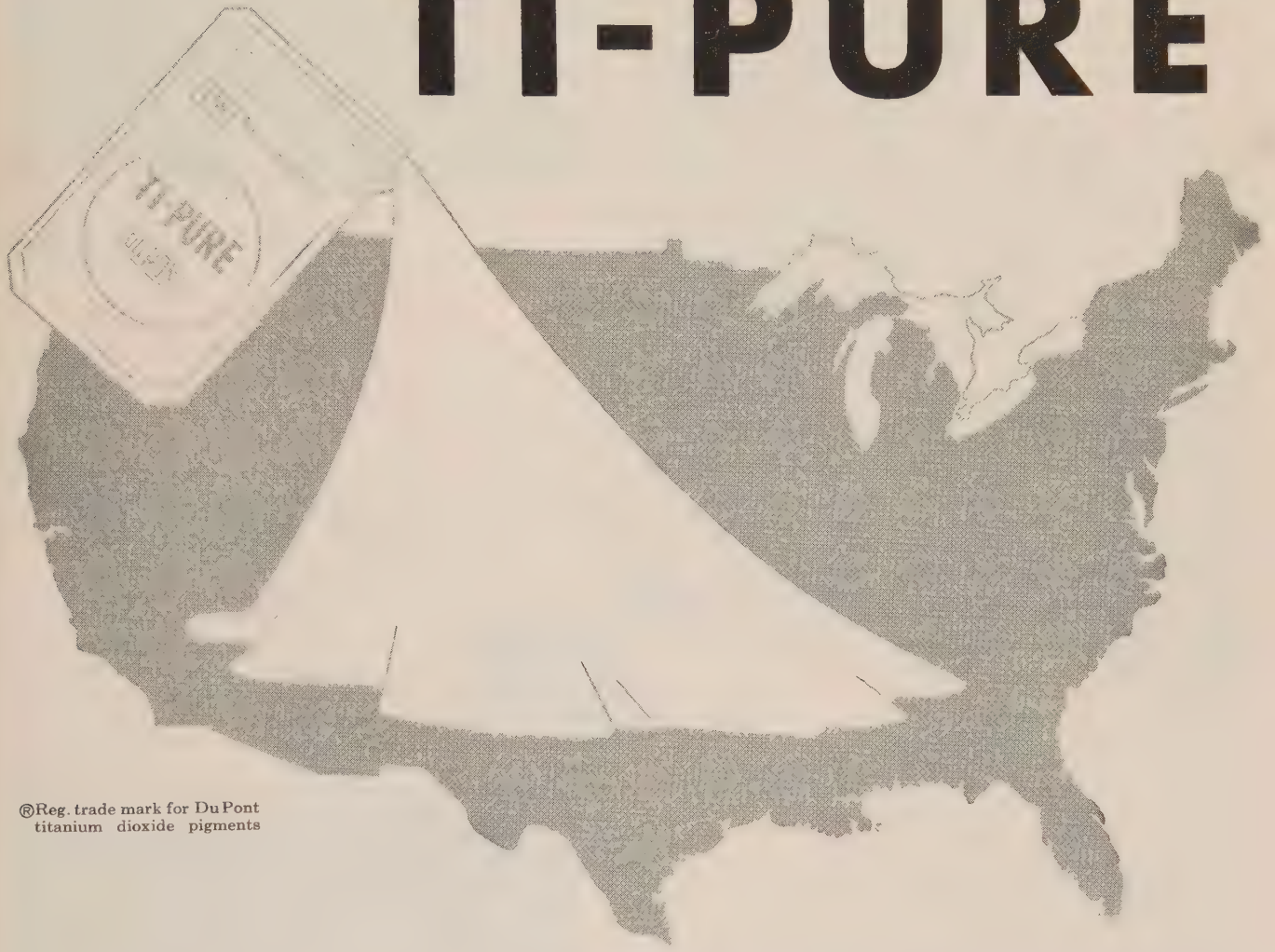

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St. Louis, Mo.
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Seattle, Wash.

been the means of obtaining new data under the sponsorship of the Hydraulics Committee of TAPPI on friction head loss of a long fibered bleached sulphite stock of 2.0, 3.0, 4.0, 5.0, and 6.0% consistency at stock velocities ranging from 1.5 to 10.0 f.p.s. The curves are similar to those obtained by Brecht and Heller. The effect of calming section length preceding and following the test section has been studied. There is some evidence that stock formation is a factor in determining the shape of the friction head loss curve.

Shear values have been determined on the long fibered bleached sulphite stock of the above consistencies using a stock shear tester. The shear values are empirical due to unsolved problems relating to stock velocities in the shear tester. The shear value has the dimensions of viscosity. However, it is not a uniform function of the velocity as for a true fluid.

A correlation of the friction head losses measured and the shear values for the pulp studied has been made. The correlation is patterned after the familiar Fanning Friction Factor Plot; the coordinates being a friction factor f and a Suspension Flow Number, Nsf. The friction factor plot has a maximum deviation of $+30\%$ for the 2.0% consistency stock and -30% for the 3.0% stock. The 4.0, 5.0, and 6.0% consistencies have much smaller deviations from a curve representing averaged values.

The correlation has been tested using previously published data and has been found to give results with a nearly constant deviation of -70% regardless of pipe diameter, stock velocity, or consistency. The deviation may be due in part to differences in shear values for the two stocks.

"Paper Tension Regulators," by G. C. Ehemann, Ohio Boxboard Co., and R. C. Berger, General Electric Co.

Our discussion will be limited to feedback control systems. These are combinations of devices which continuously measure tension, compare this measurement against a standard, and apply a corrective effort if there is a deviation from the standard.

Many papermaking and paper-processing machines have been built, in which reasonably constant tension is inherent in the design and operation of the machine. The factors which contribute to the accuracy of tension in such a machine are well worth study, since no regulating device should be used where it isn't necessary. However, if precise control of tension is required or if unregulated tension would tend to swing over wide limits, a feedback control type tension regulator may be considered.

A tension regulator, as applied to a moving web of paper or paperboard, involves the same basic principles that appear in every regulating system, whether the controlled variable be speed, temperature, pressure, or any other measurable quantity. It is the purpose of this paper to show how some of these basic principles have been applied.

The first problem in every regulating system is to measure the variable that is to be controlled. Having examined methods of measurement, the problem becomes one of assembling a regulator which can use these measurements to control web tension within the required limits.

The regulator may control tension by changing a brake pressure, field strength in a motor or a generator, adjusting a speed changer, or by other means. But between the measurement and the control device are all of the problems of regulators in general; such as, the degree of correction to be introduced for a given deviation, time constants, antihunt, range, stability, sensitivity, etc. No attempt will be made to analyze any of these considerations here. It should be recognized, however, that they may influence the choice of control scheme.

Any of the measuring elements may be used with any of the correcting elements. The control device between will depend upon the nature of the signal received and upon the kind of output required.

R. J. Barrett, (right), Vice-President of Dominion Engineering Works Ltd., supplies the details of an impulse-type hydraulic turbine to W. C. Bloomquist, C. J. Sibler, and R. G. Macdonald

"Application of Differential Drive to Paper Machines," by Sterling Skinner, Beloit Iron Works

The patented differential drive system developed by Beloit Iron Works represents a new approach to the problem of driving a paper machine, since it replaces individual regulation of driven sections with positive gearing of sections to a single line shaft. This new drive eliminates cycling or hunting.

Power is transmitted from the line shaft to each section through a differential drive unit. The major portion passes through the side of the differential which is geared directly to the line shaft. A small proportion of power passes through a variable speed transmission and is then applied to the other side of the differential. This makes possible extremely sensitive draw adjustment while insuring maintenance of whatever "fixed ratio" of sectional speeds is thus established.

The line shaft is located a short distance above the machine room floor and passes through all the differential drive units. The output shafts of these units are all at the same level. Helical gear reducers are therefore mounted at suitable angles to permit the driving of rolls in high positions as well as in low.

Controls for each section, such as for inching, running, braking, and slack take-up are conveniently located at the front of the machine.

Differential drive has been successfully applied to a number of machines in a variety of speed ranges. It is especially beneficial for conventional fourdrinier machines having a number of open draws. On machines combining open draws with a pick-up felt, the joint use of differential drive and electric helper drive gives the advantages of both. Use of electric helpers does not affect the "fixed ratio" between sections which is established by the differential drive.

Advantages of the differential drive system have proved to be even greater than originally anticipated. Draws held without variation have sharply reduced sheet breaks. Sheet tests have been raised, and there is less shrinkage in the width of the sheet.

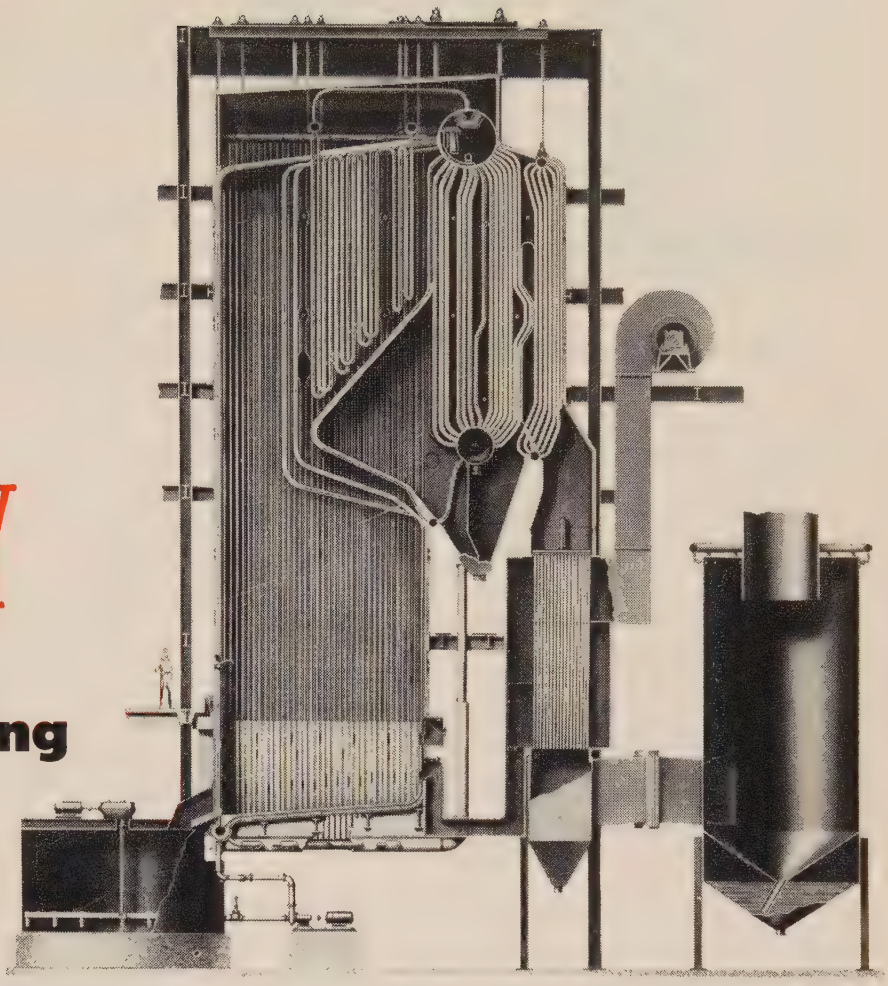
"An Engineering Analysis of Down Time of Electrical Sectional Drives," by R. F. Sorenson, Union Bag & Paper Corp.

At the Seventh TAPPI Engineering Conference, the Electrical Engineering Committee appointed a subcommittee to make a study of the lost time on paper machines due to electrical drives. Though much has been heard about the merits, as well as the various troubles encountered in the use of the

RECOVERY

at

Roaring Spring



Typical B&W Black Liquor Recovery Unit

Airview of Roaring Spring, Pa., plant of
The D. M. Bare Paper Company

The modernized Kraft mill now under construction at Roaring Spring, Penna., will put The D. M. Bare Paper Company back into pulp production, interrupted since 1951. Chemical and heat recovery will be provided by a modern 83-ton B&W Recovery Unit.

Choice of B&W equipment for this new mill further confirms B&W's ability to design and build efficient recovery boilers for large, medium, or small pulp mills. Foresighted engineering, unexcelled facilities, and many years of experience in meeting unusual requirements, form the base upon which the industry-wide reputation of B&W Recovery Units rests.

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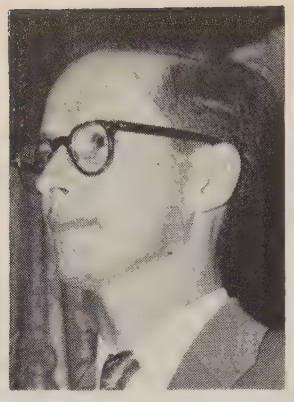
G. C. Ehemann, Ohio Boxboard Co.



R. F. Sorenson, Union Bag & Paper Corp.

electric sectional paper machine drive, records have not been available to make accurate appraisement possible. As the result of a preliminary study by this committee, the keeping of such records has been found to be not only possible, but has been shown to offer several advantages.

Tabulations from the records aid in controlling lost time by highlighting the importance of each trouble and its trend. Accurate definition of a problem is always the first step in its correction. Interdepartmental relationships are improved through a mutual knowledge of the problems that exist, an accurate assignment of these problems, and a confidence that they will be attacked in an organized manner. Records give the operating electricians a base from which to operate and an incentive to improve. Finally, every mill is interested in knowing how its electrical lost time compares with similar mills, and what goal to work toward. Weak points, as well as strong points in a mill's maintenance program come to light as a result of careful lost time tabulation.

"Variation of Drying Rates of Individual Driers Through the Drier Section" (TAPPI Research Project No. 21), by A. E. Montgomery

Forty field tests were made on 35 different paper and board machines, taking moisture samples as the paper or board progressed through the drier section. A useful technique was developed for taking samples without breaking down the sheet. The accumulated data are shown on graphs with moisture content plotted against percentage of total paper driers, thereby permitting direct comparison between machines of varied lengths. The slope of the curves using moisture on the "dry basis" provides an exact measure of the drying rate at any point.

On most machines and paper grades, it is found that the drying rate is remarkably constant from the first drier to the point where the moisture content is down to about 10 or 15%, after which it decreases rapidly and greatly. On several of the machines tested a surprisingly large proportion of the driers were used for removal of the last final percentages of moisture. In one test, 32 driers with 22 p.s.i. steam pressure were used after the moisture content of a 0.018 board sheet had been reduced to 5%. The average of six tests on writing papers showed the last 20% of the driers performed 1.5% of the total evaporation. On five tissue machines these last 20% of the driers evaporated 3% of the total water evaporated. On four tests on kraft bag machines this figure is 2%. Yet on 0.019 corrugating board the average of three machines showed 14% of the evaporation on these last driers. Sheet temperatures as well as drier surface temperatures are given for some of the tests.

The results of the tests are expected to be generally useful for intelligent location of such components as a breaker stack, size press or coater, and for proper design of a hood exhaust system or condensate removal system.

"A New Paper Machine Drying Control System," by James M. McAlear

With the advent of high-speed paper machines, Mason-Neilan began a search for a better method of paper moisture measurement and control. Up to this time our method had been a combination of sheet tension and temperature measurement, that is to say, a weighted tension roll was employed to ride the sheet of paper and when the sheet tension changed due to a new moisture content, the roll position changed. This movement was employed to actuate an air pilot valve whose output pressure then automatically shifted the index setting point of a proportional temperature controller, and the heat content was varied accordingly to the machine.

Because of higher speeds and greater machine widths, this mechanical method became impractical and a new method of pickup had to be devised. Many mechanical and electrical types of moisture pick-offs were investigated both in the laboratory and in the field and it was felt that it was preferable to utilize a measuring device which would "average" rather than provide "spot" measurement.

This new system uses a pilot drier which has a separate steam source and a pressure controller is employed to maintain the pilot drier pressure at a set point. Variations in moisture content of the sheet produce a different condensing rate of the pilot drier and the automatic pressure controller automatically varies the control valve position to supply the new heat requirement.

The variable pneumatic signal to the pilot drier steam valve is relayed to an amplifying moisture deviation recorder controller which automatically raises or lowers the index setting of the pressure controller to the main section.

The control system has great stability and holds the moisture control very accurately. Without adjustment it can be set to handle a wide variety of paper grades under varying machine operating conditions. If a break occurs, the system automatically flashes a signal light and sets the steam pressure down to a new value, so that the sheet can be restored to the machine without excessive loss in production or down time.

Mills which are using this system report improved quality and greater production. For example, one board mill reports an additional five tons of paper per day and using less steam after installation of this moisture system.

"Economics of Handling Mill Supply Chemicals," by H. A. Stoess, Jr., Fuller Co.

Methods and costs of handling mill supply chemicals are

A group of visitors inspecting a drier on the dynamic balancing machine

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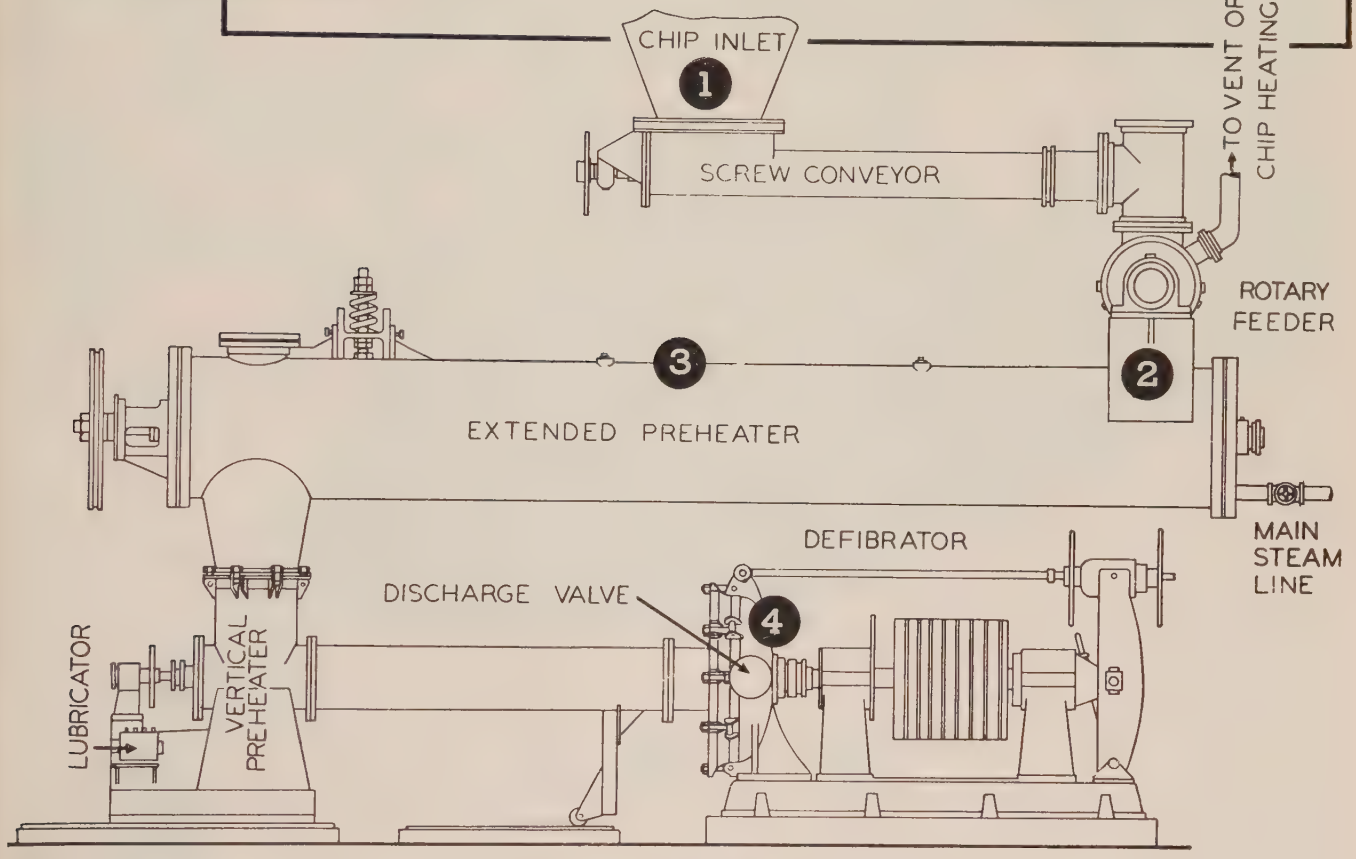


1 Drained, pre-soaked chips enter here.

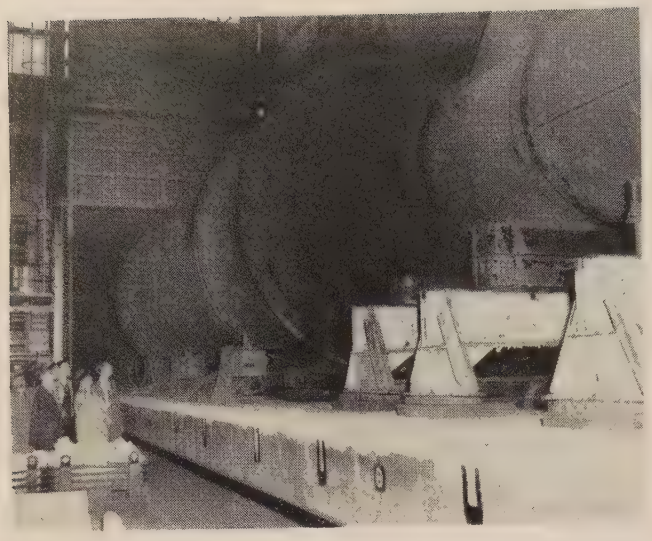
2 Rotary feeder, developed by American Defibrator, provides steam seal against pressures up to 150 psig. with no plug forming or blow-back. Chips are gravity fed without damage to fibers, change in moisture balance, or loss of liquor.

3 Chips are uniformly pressure cooked throughout as they are conveyed through the preheater, where time and temperature are controlled.

4 Softened chips are easily defibrated and pass through a blow valve to a cyclone where pulp is pumped to secondary refining.

Further details on request.

AMERICAN DEFIBRATOR, INC. CHRYSLER BUILDING NEW YORK 17, N.Y. West Coast: A. H. Lundberg Orpheum Building, Seattle, Wash.



Visitors view with interest a huge pressure vessel as it emerges from Canada's largest stress relieving furnace at Dominion Bridge Lachine plant

discussed from information received from representative mills. Costs are noted as well as operating advantages and disadvantages.

Chemicals mostly used by the industry are individually discussed. Included is the method of receipt and handling with percentages of the various methods. Types of storage for the chemicals in use are also given.

"A Pulpwood Flume System," by John A. Fielding

The flume system was developed to provide necessary wood handling facilities for a nominal mill production of 1985 tons per day (1585 from pine, 400 from hardwood). Storage yards, distribution to the existing wood room, new wood room for either pine or hardwood, modern unloading equipment and rail facilities for 200 cars per day are the basic requirements.

The flume is rectangularly shaped, providing rack car unloading sections 1000 ft. long on the east and west sides with truck dumping facilities along the south section for a total flume length of 3200 ft. The hydraulic gradient of the flume is designed for a velocity of 5 f.p.s. using 45,000 g.p.m. to handle 200 cords per hour.

To insure satisfactory flume operation, a settling basin to allow suspended solids to drop out and traveling water screens for bark removal were provided.

"The Application of Noncorrosive Materials," by George Lydick, Beckett Paper Co.

Many noncorrosive materials are available for use in the paper industry. A discussion of the materials available for use in sulphite pulp and paper mills includes the use of brick, tile, and cement linings for towers, tanks, and digesters. Lead linings and lead pipe are mentioned in their application to tanks, vats, and other tankage.

Rubber linings and the plastic variety of coatings are discussed along with the use of phenol-resin compounds, that can be sprayed on metal surfaces and then baked or dried, under elevated temperatures.

The increased usage of stainless steel and Monel for tanks, tubing, and piping is given considerable thought, because of the very prominent part it is playing in the manufacture of paper.

Special applications of large diameter rubber hoses are mentioned as a possible cure for conditions where solids clog pipe lines, because of corrosive conditions.

In the kraft mill or soda process mill the use of special cement to withstand the ravages of salt cake and black liquor is discussed. These applications to floors, walls, and tank linings are considered. The advantage of this cement in mortar for walls is also pointed out as a cure for the damage that salt cake can cause.

With the use of the noncorrosive materials mentioned above for use in the sulphite mill, a detailed discussion is made of their application to the kraft and soda process mill. Certain types of mastics that can be built up in successive layers over glass fiber membranes are mentioned also for their usage in tanks, vats, and large diameter pipe.

The use of asbestos cement pipe and fittings is carefully considered and compared to other piping.

Generally, the increased usage of noncorrosive materials means better availability of them, along with increased profits to the mill operators.

"Maintenance of Pipe Lines—Internal Cleaning," by C. W. Ziegenbusch and M. V. Jones, Mead Corp.

Pipe cleaning may mean many things to papermakers. The maintenance man, chemical engineer, chemist, pulp mill operator; to each, the maintenance of internally clean pipe lines brings a different picture.

We shall not deal with the original design and operational factors of pipe lines within this paper, but shall include a short physical description of equipment more commonly used and the mechanical application of these devices.

Pipe cleaning methods may be classified as (1) mechanical, (2) chemical, (3) hydraulic.

Mechanical methods used are usually of the power or the bucket and scoop types.

Power type equipment consists basically of an electric motor or gasoline engine power source for rotational motion, a flexible shaft, and a cleaning tool.

Bucket and scoop type of mechanical cleaning utilizes power winches at each end of an open straight pipe line and the pulling of a bucket through the pipe until a load of foreign material has been gathered in the bucket, after which the direction of the bucket is reversed until the load is withdrawn from the pipe.

Chemical pipe cleaning methods include the "fill-and-soak," and "pump circulation" procedures.

The two most common methods for hydraulically cleaning pipe are the jet type and the pig type. A feature common to both is that they depend upon fluid pressure for propelling the cleaning apparatus through the pipe.

The jet type does its cleaning normally by means of water pressure alone, using pressure of from 800 to 2000 p.s.i.

In general, the pipe cleaning pig consists of anything that will fit inside the pipe to be cleaned, maintain its assembled shape under pressure without collapsing, and provide a reasonably good seal so that little or no fluid will flow past it.

One combination of the above pipe cleaning methods has also been used.

"Promising Indications of the Causes of Corrosion in Alkaline Pulping Equipment," by C. B. Christiansen

Under the sponsorship of a large segment of the Canadian kraft industry, the Pulp and Paper Research Institute of Canada organized a task force of scientists to undertake an intensive, comprehensive, and direct study of corrosion problems in the kraft mills. This approach, which is unique to the Canadian industry, was adopted because of the dearth of fundamental knowledge concerning the problem.

Since the problem is worldwide, effective liaison has been maintained with groups in other countries who are carrying out studies in the laboratory and by questionnaire.

Fifteen mills have now been surveyed and data accumulated on 125 variables which may affect corrosion. It is now evident that there are two distinct sets of forces which result in the wasting away of digester steel. One set combines to form primary corrosion resulting from the interaction of wood, liquor, and steel during the cooking process. These forces, it is believed, produce a broad surface attack on digester walls.

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Superimposed on the effects of primary corrosion are secondary effects owing to the presence of scale, uniformity of steel, fabrication methods, digester design, and certain operating practices. These tend to accentuate and localize the attack in some areas and preclude it in others. These secondary forces determine the major corrosion patterns found in digesters.

From the volume of data collected, Arthur D. Little, Inc., Cambridge, Mass., has developed a chemical hypothesis based on the interactions of sodium hydroxide, sodium sulphide, and sodium thiosulphate. This empirical equation has shown a remarkable agreement with experimental data made available through liaison and also with mill data collected by the task force.

More than 40 steel samples taken by the task force are now being subjected to a metallurgical investigation which comprises over 31 individual determinations and is the most exhaustive and comprehensive metallurgical study ever made in Canada. Upon completion of the metallurgical work, it should be possible to identify the specific metallurgical factors in the corrosion problem and to recommend the types of carbon steel most resistant to the corrosion environments found in kraft pulp digesters.

"Safety Evaluation and Protection of Digesters," by W. B. Parker, Hartford Steam Boiler Inspection and Insurance Co., and H. M. Canavan, Mutual Boiler and Machinery Insurance Co.

The visual examination of the digester and its appurtenances is an essential part of any in spection, as it is the basis of all other study. On the basis of this inspection proper areas for further study may be selected whether such study consists of additional thickness readings, location of plate or weld samples, the location of critical areas as the result of corrosion, or the examination of a defective forge weld. The results of the visual examination should be recorded in detail on the TAPPI data sheet for ready reference.

For the safety evaluation of any digester to be of value the thickness of the remaining metal in the digester shell and heads must be accurately determined. This may be accomplished by drilling if other means are not available. However, a more desirable means would be by use of the Audigage or other thickness-measuring instruments, obtaining thickness readings at regularly spaced intervals over the entire surface of the shell and heads, recording these thickness readings on the TAPPI data sheet.

An analysis of the completed data sheets will determine the location of any critical areas in the digester, the safety status of the digester, the location of any areas requiring repair, and an estimate of the remaining service life.

The need for providing adequate safety valve protection on digesters as a protection against excessive internal pressure has long been recognized. A study of the individual digester will determine the protection required and the best method of providing that protection.

"Fire Protection of Pulp and Paper Mills," by R. C. Max, Factory Insurance Association

This presentation concerns itself with the several fundamental facets of fire safety as it applies to pulp and paper mill classifications together with their conversion and related production processes. The theme of the paper contains all the important factors necessary in building up and working toward a "fire-safe" plant beginning with the construction of the mill, application of fire protection equipment, and personnel fire safety organization and training. Lessons learned from recent large-scale and crippling fires will be interjected in the discussion.

The principal points of the paper include *Building Construction* with subtopics on kinds of mills from standpoint of age and kind of fire protection afforded, degree of fire safety based on type of construction, features designed to restrict spread of fire, structural deficiencies, and fire hazards of buildings under construction, *Fire Protection Equipment Applications* with emphasis on sprinkler system installations and water supplies, significance of new spray heads, special types of extinguishing equipment for special hazards, and annual testing procedures; *Special Occupancy Protection* in various types of paper mills from the standpoint of recognizing and adequately protecting against the danger points in production processes from a fire and explosion standpoint such as chip bins, sulphur handling, paper dust removal, stock storage problems including the special problems of wastepaper and rolled paper storage, paper machine hood protection, boiler combustion safeguards, and coating and printing processes employing flammable liquids.

The plate rolls at Dominion Bridge plant were a focal point of interest for TAPPI visitors

The main subdivisions of the paper continue on *The Protection of Pulpwood Yards* where mention is made of piling standards, hydrant protection, pumping apparatus, etc., and *Electrical Protection in Paper Mills* regarding turbogenerators, transformers, and lightning protection. The importance of an *Employee Fire Brigade Organization* is brought out with a word on use of fire fighting equipment, an effective training program, inspection procedures, and good watchman service. *Miscellaneous Items* include a short résumé of typical fires in pulp and paper mills and elimination of fire causes together with salvage possibilities, lessons learned from disastrous fires in general, and finally, the importance of good housekeeping and good maintenance.

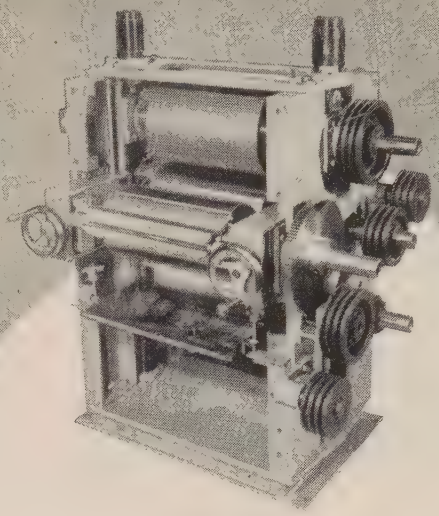
The paper is concluded with a note on the vital importance of attaining a high level of management, supervision, and labor personnel cooperation.

"Industrial Plant Construction in Canada," by F. M. Kraus, Stadler, Hurter & Co.

The spectacular development of Canadian industry in the past decades has gained for Canada the respect of other nations and placed her in the position of a major industrial power. This achievement and its continuing rise is largely due to the sound engineering ability of Canadian contractors, manufacturers, and consultants. The knowledge of the locality, the close contact and understanding between the contributors to construction cannot be replaced by numbers of personnel or machines.

The geographic position of the country affords opportunities to meet almost any condition, from the Arctic permafrost areas to the high humidities of the West Coast; the expanses of the Prairies or the Laurentian Shield; each with their seasonal trends in temperature and precipitation.

Canadian builders have to contend with temperatures as



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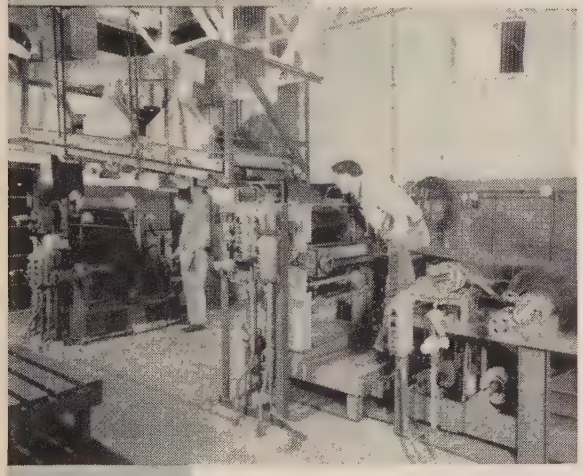

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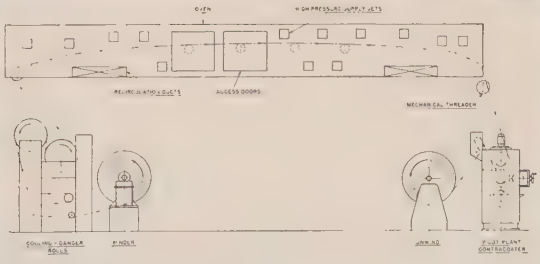

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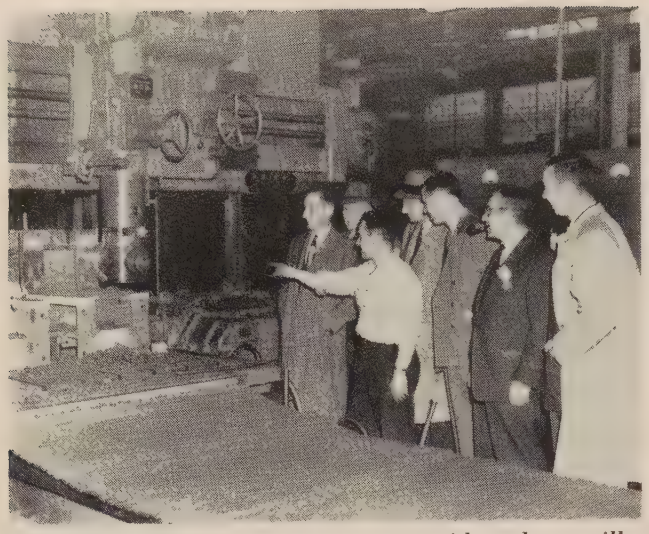

TAPPI visitors watch 70-ton open side, plano-miller operating at the Lachine plant of Dominion Bridge. This machine is one of the largest in Canada. As its name implies, it combines the functions of a planing machine and milling machine

low as 40°F. below zero, and as high as 120°F. They have to contend with rock as hard as cast iron, or sink into sand or muskeg without apparent support or bottom. They also have to fly their material on site, or use tractor trains cross-country in Winter, in order to stay on the ground surface and on schedule. They may have to bring materials 3000 miles by trail, train, boat, and aircraft all in the course of one operation. The construction seasons are often short—up to 6 months only—and there are areas on the West Coast where it rains 300 days out of 365. Consultants' and contractors' work, therefore, is geared to meet the challenge.

A wide variety of construction materials is adapted to this task. Winter concrete is a regular feature, despite the water, which tends to freeze. Precast units are used, not only as time and money-savers, but also because they are particularly advisable when winter sets in or threatens to overtake the construction schedule.

Structural steel has shown that its limited shipping weight and knocked-down sections are a great help toward flexibility of construction. Timber has gained wide acceptance as good frost insulator; a high-grade and readily available material in the shape of laminated, solid, or trussed members. Plywood has been used to advantage in beam and wall construction—as a fact complete auxiliary units are fabricated and shipped dismantled to the job and erected there with marked success.

Prestressed concrete is passing through the stage of adaptation and its advantages lie in the quantity and repetition of typical members. It is a competitive material under watchful consideration.

Enclosure of buildings features a multitude of wall types, starting with reinforced concrete and brick, and passing through lightweight types of only a few pounds' weight per square foot of wall.

These salient points, of course, lead to cost comparison as diversified as the means employed. There is, however, a growing trend in this country toward more competition and economical use of material.

"The ASME Code and Its Application in the United States and Canada," by E. C. Korten, Hartford Steam Boiler Inspection and Insurance Co.

The Code came into being because of continuously increasing explosions which killed and maimed and caused heavy property damage. One of its objectives was to combat the then-current false notions of the causes of explosions by establishing a sound basis for selection of material, for design and for workmanship. In drafting the first Code it soon became apparent that the original intent to include enforcement was unworkable. Enforcement was therefore left where it belonged—with state and city authorities.

The Code Committee formulates the rules for the construction of new equipment. It meets seven times a year to keep the Code up to date and to answer inquiries. The Code is adopted by most states and cities as the basis of acceptable construction and they set up the rules for installation and periodic inspection. The Code requires inspection during construction by state, city, or insurance inspectors. Inspectors are commissioned by the state or city on the basis of a written examination. Manufacturers are responsible for Code compliance of new construction, but users are responsible to the state or municipal authority for compliance with the law.

The user's best counsellor in ASME Code application is his insurance carrier. Where no boiler insurance is carried, the state or city authority should be consulted. Requirements in the United States and Canada are summarized in the National Bureau of Casualty Underwriters' bulletin "Synopsis of Boiler Laws, Rules, and Regulations."

Application in Canada closely parallels that in the United States. All designs must clear through the provincial authority. Their guide-book is the Canadian Standards Association Standard B-51 compiled by the Committee on Boilers and Pressure Vessels.

Welded piping covered by the Code is somewhat of an orphan. It can cause the user much trouble unless fabricated and erected by an authorized contractor and inspected during fabrication and erection. For construction which cannot be made to conform to Code requirements, the enforcement authority is the proper clearinghouse.

"Case History of an 850 P.S.I.G. Topping Turbine Installation," by H. R. Emery, St. Regis Paper Co., and P. L. Nelson, Chas. T. Main, Inc.

The original steam and power generating equipment, intalled in the St. Regis Paper Co., Deferiet mill, became obsolete and was first replaced in the years between 1913 and 1921. During the period from 1936 to 1944, studies were made with a view toward replacing that steam plant equipment which had become obsolete and reducing the power plant operating costs. These studies culminated in the installation in 1946 of two boilers rated 100,000 lb. per hr. each, 875 p.s.i.g., and 850°F. TT, and one noncondensing 6000-kw. topping turbine-generator unit. The exhaust from this new noncondensing turbine supplies all mill processes and an existing low pressure 5000-kw. condensing turbine-generator unit.

Operation of this installation has been successful and costs indicate, under present operating conditions, a saving of $2.75 per ton of paper produced over a similar quantity of steam and power produced with the previous equipment.

"Interpreting Performance Curves of Single and Double Extraction Turbine Generators and the Use of Heat Rates as a Method of Calculating Power Costs," by J. Gottlieb, Westinghouse Electric Co.

Power and steam production in paper mills is one of the major "raw materials" that go into pulp and paper production.

One of the important factors in evaluating the cost of this "raw material" in the price of the end product is the proper segregation of the cost of fuel into the two components—(1) electric power, (2) steam at various pressures.

The purpose of this paper is to describe the construction of the performance curves for single and double-extraction turbine generators. Then show how these curves can be converted to heat rate curves. The heat rate curves can then be used to establish heat rates from which the cost of power can be easily calculated.

A general description of modern turbine-generator units and paper machine drive units will conclude the paper.

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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Winthrop Allen, Purchasing Agent and Director of Research, The Mengel Co., Louisville, Ky., a 1916 graduate of the University of Pittsburgh.

John W. Anderson, Plant Engineer, McLaurin-Jones Co., Brookfield, Mass., a 1932 graduate of the University of Cincinnati.

Felix F. Axelrad, Plant Manager, Fiber Chemical Corp., Matawan, N. J., a 1926 graduate of the Technical University, Vienna, Austria, and a 1930 graduate of the Technical University, Berlin-Charlottenburg, Germany.

Elmer H. Balkema, General Purchasing Agent, Colgate-Palmolive-Peet Co., Jersey City, N. J., a 1926 graduate of Purdue University.

Horst D. Berg, Assistant to the President, Ratinger Papierfabrik, Ratinger (Rhld), Germany, a graduate of Cologne College with an Eng.D. degree.

Hans Bettschen, Tour Boss, W. R. Grace Co., Paramonga, Supe, Peru, a 1951 graduate of O. V. Miller Polytechnikum, Munich, Germany.

Jasper Bresler, Technical Director, Rigesa S. A., Valinhos, S. P., Brazil, a 1928 graduate of Grey College.

Lawrence A. Carlsmith, Engineer, Improved Machinery, Inc., Nashua, N. H., a 1953 graduate of Massachusetts Institute of Technology.

Thomas L. Cline, General Manager, State Container Co., Biglerville, Pa., a 1943 graduate of Gettysburg College.

Grant G. Cole, Development Engineer, The Diamond Match Co., Pulp and Paper Div., Plattsburg, N. Y., a 1947 graduate of Clarkson College of Technology.

George C. Collier, Jr., Plant Manager, Connelly Containers, Pencoyd, Pa., a 1942 graduate of the University of North Carolina.

John G. DePagter, Chemical Engineer, Crossett Lumber Co., Crossett, Ark., a 1952 graduate of the University of Arkansas.

Kent Dickerman, Jr., Student, Western Michigan College, Kalamazoo, Mich.

Richard J. Drexel, Jr., Project Chemist, Edgar Brothers, McIntyre, Ga., a 1950 graduate of the University of Georgia.

George M. Griffith, Jr., Engineer, West Virginia Pulp & Paper Co., Luke, Md., a 1952 graduate of the University of Iowa.

Cecil L. Harvey, Application Engineer, Pulp and Paper Industry Specialist, Elliott Co., Ridgway, Pa., a 1939 graduate of the University of Maryland.

Gus R. Holm, Proprietor, Derrico-Canastota Co., New York, N. Y.

Sydney W. Hooper, Executive Assistant to the President, Hydraulic Machinery Co. Ltd., Montreal, P. Q., Canada.

Maung Shwe Htoo, Industrial Research Fellow, University of Maine, Orono, Me., a 1952 graduate of the University of Maine.

Millard B. Hunter, Jr., Sales Engineer, The International Nickel Co., Inc., New York, N. Y., a 1950 graduate of Union College.

Paul W. Jacobsen, H. G. Weber & Co., Inc., Kiel, Wis. Attended Rutgers University.

Ted Jewson, Student, Western Michigan College, Kalamazoo, Mich.

J. Kjeller Johansen, Chief Engineer, A/S Meana Traesliperi og Kartonfabrik, Lilliehammer, Norway, a 1928 graduate of The Technical University of Norway.

Harold S. Johnston, President and General Manager, Filter Materials, Inc., Waupaca, Wis.

James S. Juba, Design Engineer, St. Regis Paper Co., Cantonment, Fla., a 1951 graduate of Clarkson College of Technology.

Lauri L. Kangas, Superintendent, Fitchburg Paper Co., Fitchburg, Mass.

John F. Kneeland, Salesman, Arnold, Hoffman & Co., Inc., Providence, R. I., a 1946 graduate of Bates College.

Louise Lefebvre, Librarian, Pulp and Paper Research Institute of Canada, Montreal, P. Q., Canada, a graduate of the University of Montreal.

Carter McClure, Engineer, Stevenson & Rubens, Seattle 4, Wash.

Joshua K. Missimer, Research Papermaker, National Bureau of Standards, Washington, D. C. Attended George Washington University and the University of Richmond.

Robert O. Nason, Chief Chemist, Crossett Chemical Co., Crossett, Ark., a 1937 graduate of Tri-State College.

Chester H. Pedersen, Sales Engineer, Electric Steel Foundry Co., Portland, Ore., a 1947 graduate of the University of British Columbia.

Rohe V. Pennington, Jr., Plant Engineer, National Container Corp., Jacksonville, Fla., a 1945 graduate of the U. S. Naval Academy.

Albert P. Peyer, Jr., Assistant Pulp Mill Superintendent, Hollingsworth & Whitney Co., Mobile, Ala., a 1937 graduate of the New York State College of Forestry.

Paulo de Abreu Ribeiro, Engineer, Ribeiro Parada S/A, Sao Paulo, Brazil, a 1945 graduate of the University of Sao Paulo.

Alfred Ross, Plant Superintendent, Allcraft Container Corp., Harrison, N. J.

Edward N. Ross, Production Assistant, Lee Paper Co., Vicksburg, Mich., a 1949 graduate of Yale University.

Charles E. Rozema, Technical Representative, Rohm & Haas Co., Resinous Products Div., Philadelphia, Pa., a 1929 graduate of Purdue University.

Roger E. St. Pierre, Chemical Engineer, Brown Co., Berlin, N. H., a 1951 graduate of New England College.

Edmond L. Smith, Engineering Sales, Combustion Engineering, Inc., New York, N. Y., a 1928 graduate of the University of Texas.

Fred B. Speyer, Research Chemist, Pierce & Stevens, Inc., Buffalo, N. Y., a 1940 graduate of Kalamazoo College.

George B. Stanton, Jr., Chief Chemist, Arvey Corp., Jersey City, N. J., a 1948 graduate of Brooklyn Polytechnic Institute.

William R. Streed, President and General Manager, Streed Fabricating Co., Inc., Camp Sibert, Attalla, Ala. Attended Indiana Technical College.

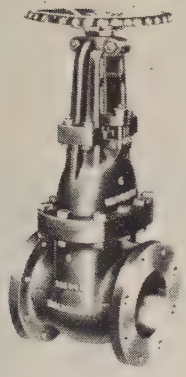
C. Edward Taylor, Assistant to Paper Mill Superintendent, Crown-Zellerbach Corp., Port Townsend, Wash., a 1949 graduate of the University of Colorado, and of the Institute of Paper Chemistry in 1951.

Charles T. Turner, Vice-President, Machine Div., Flynn & Emrich Co., Baltimore, Md., a 1940 graduate of Princeton University.

Tadashi Usui, Chief Engineer, Chuetsu Pulp Industry Co.

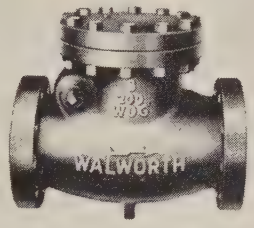
Walworth

Valves and Fittings



WALWORTH No. 725FS OS&Y, Flanged, Special Alloy Wedge Gate Valves were developed especially for the pulp and paper industry. They are available in sizes from 2 to 12 inches for 200 pounds, and 14 to 24 inches for 150 pounds, non-shock service.

WALWORTH No. 928FS Swing Check Valves are recommended for use with No. 725FS Gate Valves. Like No. 725FS, they are designed to meet fully the requirements of the pulp and paper industry.



WALWORTH No. 716 is an OS&Y, Saddle Style, Wedge Gate Valve having body, bonnet, and wedge of Ni-Resist. The seat rings and stems are of 18-8 stainless steel. These valves are available in sizes ½ to 2", and complement the No. 725FS valves in the smaller sizes.

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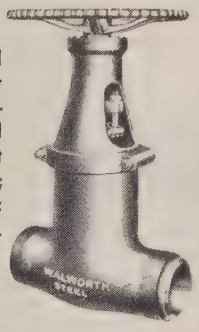

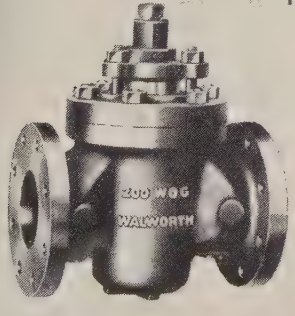

WALWORTH No. 1700F Lubricated Plug Valves are available in a variety of materials for corrosive service. They assure long life and positive operation; are wrench or gear operated; have a working pressure of 200 pounds WOG; and are available in sizes from 1" to 8".

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Robert Weller, Paper Mill Engineer, Marinette Paper Co., Fort Edward, N. Y., a 1943 graduate of Lehigh University.

Thomas E. Whitson, Technical Service Dept., Velsicol Corp., Chicago, Ill., a 1947 graduate of Washington University, St. Louis.

Edward M. Williston, Senior Technologist, Weyerhaeuser Timber Co., Longview, Wash., a 1940 graduate of Pennsylvania State College.

Charles L. Witham, Sales Engineer, Ciba Co., Inc., New York, N. Y., a 1938 graduate of Union College.

Frederic B. Woodward, Purchasing Agent, Sheppard Envelope Co., Worcester, Mass.

James R. Wright, Pulp Mill Superintendent, Green Bay Paper & Pulp Co., Green Bay, Wis., a 1949 graduate of the University of South Carolina.

Sone Yoshitoshi, Manager, Engineering Dept., Mitsubishi Heavy Industries Reorganized Ltd., Mihara-City, Hiroshima Pref., Japan.

TAPPI Notes

William F. Allen is now Manager of Market Development for A. E. Staley Mfg. Co., Decatur, Ill.

Henry E. Arkens, Technical Salesman for the Ansul Chemical Co., has been transferred from Marinette, Wis., to Detroit, Mich.

Frank J. Ball is now Director of the Development Dept., West Virginia Pulp & Paper Co., Charleston, S. C.

Samuel M. Bratton is now Chief engineer of the Pusey & Jones Corp., Wilmington, Del.

Rolf O. Christiansen, formerly of A. Ahlstrom O/Y, is now with A/B J. W. Enquist O/Y, Lielahti, Finland.

C. W. Converse of Sprout, Waldron & Co., Muncy, Pa., has been touring mills in Japan. On October 6 he was the speaker on the program of the Japanese TAPPI in Tokyo. His subject was "Semichemical Pulping."

Hilliard D. Cook is now General Manager of the Sweet Paper Corp., Phoenix, N. Y.

Howard H. Dana, formerly of the Curtis Publishing Co., is now Manager of the Production Div., Providence Lithograph Co., Providence, R. I.

John D. Davis is now serving as Director of the Forest Products Div. and Assistant Director for Pulp and Paper in the Business and Defense Services Administration in Washington, D. C. He expects to return to the Mead Corp., Chillicothe, Ohio, in January.

Edward Engel is now Purchasing Research Manager of the Celanese Corp., Charlotte, N. C.

Peter J. Fitzpatrick is now a Salesman for the Paper Chemicals Dept., American Cyanamid Co., Boston, Mass.

Joseph F. Gill, formerly of the Ryegate Paper Co., is now Plant Manager of the Mountain Waterproof Papers, Inc., Worcester, Mass.

Philip H. Goldsmith is now Sales Manager of Pusey & Jones Corp., Wilmington, Del.

Albert F. Goldstein, formerly of Gordon Cartons, Inc., is now President of the Arundel Coating Corp., Baltimore, Md.

E. G. Greenman, Jr., formerly of the Mid-States Gummed Paper Co., is now with the Munising Paper Co., Munising, Mich.

Paul B. Hansen, formerly of the Bergstrom Paper Co., is now in the Research Dept. of the Kimberly-Clark Corp., Neenah, Wis.

B. W. Haskell is now Resident Engineer of Rayonier, Inc., Fernandina, Fla.

George A. Hermann resigned from the Hermann Mfg. Co., Lancaster, Ohio, on October 15. The Hermann Mfg. Co., manufacturers of the Hermann Improved Claflin refiner and the TAPPI standard pulp testing sheet making apparatus, was sold to Essex Wire Corp., Detroit, Mich., in June, 1951. Mr. Hermann has been active in the paper industry since 1929. Until further notice, he will be located at his home address, 722 Neil Ave., Lancaster, Ohio.

Harold N. Holcombe, formerly of the Schmidt & Ault Paper Co., is now Technical Director and Production Engineer of Chrono Products Co., York, Pa.

Everett Ingalls, Jr., formerly of the S. D. Warren Co., is now Assistant Production Manager, Central Paper Co. Div. of S. D. Warren Co., Muskegon, Mich.

Raphael Katzen, formerly of the Vulcan Copper & Supply Co., is now a Consulting Chemical Engineer, Cincinnati 13, Ohio.

Frank Kaulakis, formerly of the S. D. Warren Co., is now Technical Service Representative of Clinton Foods, Inc., Clinton, Iowa.

George McCrea is now a member of the head office staff of the Mead Corp., Chillicothe, Ohio.

D. Kenneth McCurdy is now Laboratory Supervisor of the Glassine Paper Co., West Conshohocken, Pa.

B. C. McMahon is now Production Manager of the Canada Paper Co., Windsor Mills, P. Q.

Howard Merkle, formerly of the Empire Box Co., is now with the United Board & Carton Corp., Thomson, N. Y.

Oscar L. Miller, formerly of the Marcalus Mfg. Co., is now Technical Director of Durham Paper Board Co., Durham Furnace, Pa.

Harry V. Miles, Jr., formerly of the U. S. Hoffman Machinery Corp., is now a Research Engineer of Oliver United Filters, Inc., Oakland, Calif.

Charles J. Seiler, formerly of the Bakelite Co., is now with the General Electric Co., Coshocton, Ohio.

H. Scott Smith is now Paper Mill Superintendent of Fibreboard Products, Inc., San Joaquin Div., Antioch, Calif.

O. H. Somers, formerly of the Western Printing and Lithographing Co., is now Superintendent of Quality Control Engineering, Olin Industries, Inc., Arms and Amunition Div., New Haven, Conn.

Peter J. Vakomies, formerly of the Irving Pulp & Paper Co., is now Project Engineer for Sandwell & Co., Ltd., Vancouver, B. C.

Roy P. Webber II, formerly of the U. S. Air Force, is now in the Technical Service Dept. of the West Virginia Pulp & Paper Co., Charleston, S. C.

William F. White, Sales Engineer of the Oliver United Filters, Inc., has been transferred from Chicago, Ill., to New York, N. Y.

* * *

Nathaniel G. McLean, Chief Engineer, is now the official corporate representative of Finch, Pruyn & Co., Inc., Glens Falls, N. Y., in TAPPI, succeeding *R. I. Wynne-Roberts*, deceased.

The name of the Sweet Bros. Paper Mfg. Co., Phoenix, N. Y., has been changed to Sweet Paper Corp.

* * *

The name of Geigy Co., Inc., has been changed to Geigy Chemical Corp., 89 Barclay St., New York 8, N. Y.

L. Earl Slusher, Assistant Sales Manager, is now the official representative of Industrial Nucleonics Corp., Columbus, Ohio, in TAPPI.

Industry Notes

PRODUCTION

In August, as the industry's total output amounted to 2,300,000 tons, production again exceeded output for the

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Begin with a good company, add liberal quantities of technical skill and the will to serve. Flavor with specially trained sales representatives, and informative advertising. Mix well with experience for nearly 50 years. This formula has made Bolton products and service outstanding in the pulp and paper industry.

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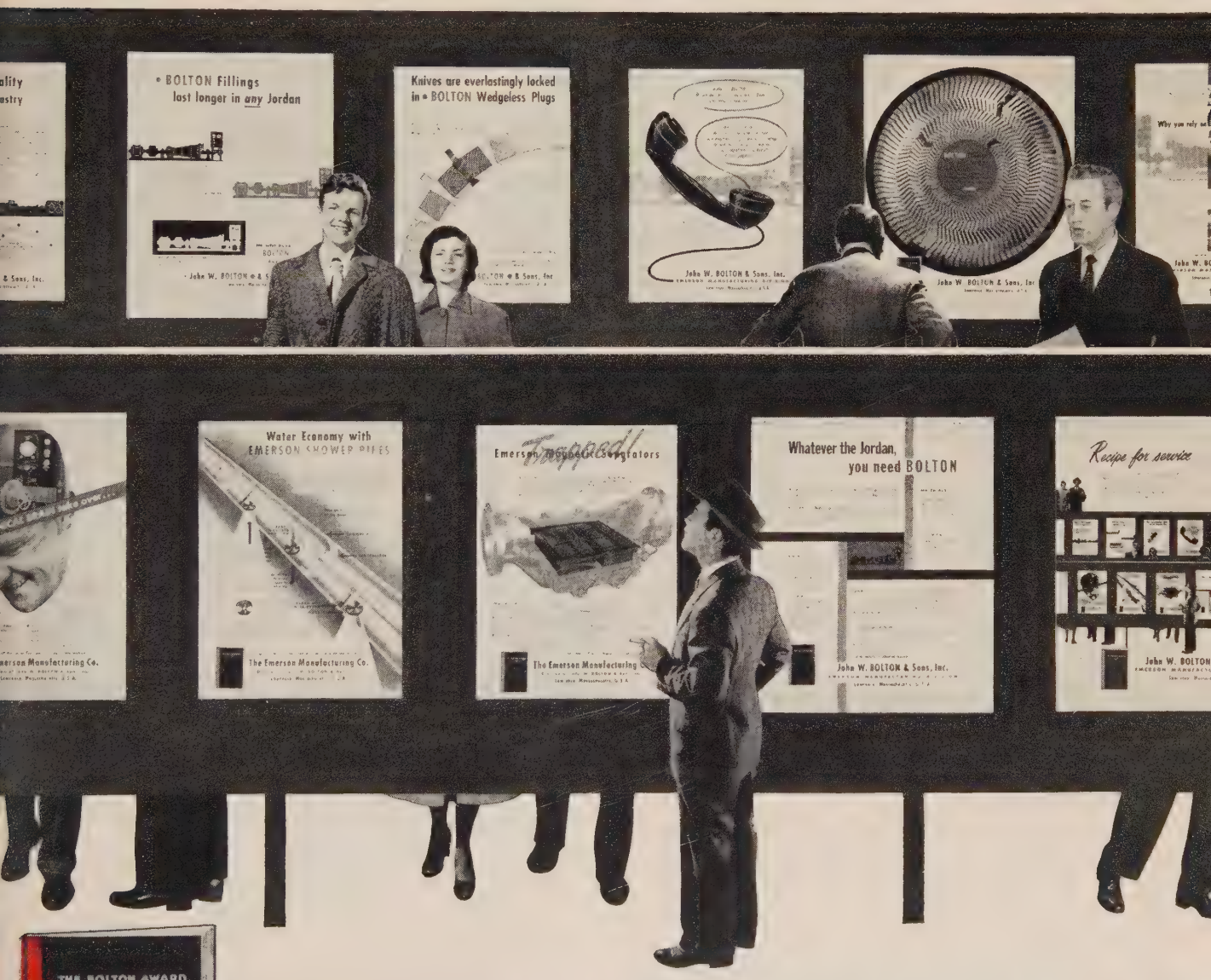
• BOLTON Fillings last longer in any Jordan
Knives are everlastingly locked in • BOLTON Wedgeless Plugs
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Whatever the Jordan, you need BOLTON
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same month in 1951. Production in August was not only the largest ever achieved for that month, but also represented the fourth best month in the history of the industry. Production for the first 8 months, amounting to 17.7 million tons, was approximately 2% less than for the same period in 1951, but 11% larger than in 1952.

Printing paper production in August amounted to 316,000 tons, the largest volume ever produced in a single month by this segment of the industry. Fine paper production was 113,000 tons, 13% more than for August, 1952, but 3% less than for August, 1951. Coarse paper production was 268,000 tons, about 6% below the average for the first 6 months of 1953. Paperboard production amounted to 1,100,000 in August and 8.3 million tons for the first 8 months of 1953, about 1% less than for the same period of 1951.

Wood Pulp

Wood pulp production for the first 6 months of 1953 amounted to 10,142,000, 6% more than for the corresponding period in 1952. August wood pulp production was 1,529,716 tons. United States wood pulp imports are shown in the following table:

	1953	*1952*	*% Change*
Canada	1,056,206	1,035,431	+ 2
Sweden	234,210	70,071	+208
Finland	115,325	61,870	+ 86
Norway	28,030	10,633	+164
Germany	588	169	+248
France	200	119	+ 68
Austria	7,258	...	...

Wastepaper

Wastepaper consumption during the first 8 months of 1953 amounted to 5,714,534 tons, a drop of 10.9% from the corresponding period in 1951. If the present consumption rate is maintained until the end of the year, 1953 consumption of wastepaper will equal that of the record-breaking year of 1951.

Forest Congress

The American Forestry Association's American Forest Congress, held in Washington, October 29–31, featured prominent government and industry speakers in a reappraisal of the nation's forest situation. President Eisenhower opened the Congress, which was addressed by Sherman Adams, assistant to the President, Ezra T. Benson, Secretary of Agriculture, Douglas McKay, Secretary of the Interior, R. H. Winters Minister of Resources and Development in Canada, and James L. Madden, president, American Forest Products Industries. "Over-all Opportunities and Aims" was the general subject of the congress, which included sessions on forest management, multiple use of forest lands, opportunities in research and education, and forest land ownership.

Community Dependency

The American Paper and Pulp Association, 122 E. 42nd St., New York 17, N. Y., has published a Study of Community Dependency on the Pulp and Paper Industry.

Industry Overexpanded?

"Has the Pulp and Paper Industry Overexpanded?" is the title of a publication by John H. Vogel of the American Paper and Pulp Association, 122 E. 42nd St., New York 17, N. Y.

Bagasse Newsprint

A judiciary subcommittee of the House of Representatives has stated that sugarcane waste offers a promising solution to world newsprint shortages. The subcommittee set the world-wide bagasse potential at 25,000,000 tons per year, and said that in the United States sufficient quantities of bagasse are produced annually to support two economic newsprint mills in the South.

Paper Box Uses

A St. Louis manufacturer reports that nails are now being shipped in corrugated boxes instead of wooden kegs. A paper box maker in Sandusky, Ohio, has produced a heavy-duty box for shipping large electrical insulators, and a special box has been designed for carrying tropical fish.

Brazil

A new bleached sulphite mill utilizing eucalyptus wood as a raw material is to be constructed in the east central area of Brazil, at a cost of $6,000,000. The mill is to have a daily capacity of 50 tons of bleached pulp, or about 15,000 tons per annum. Pulp from the mill will be used in making writing, printing, bond, book, and other types of paper. The mill is being constructed for Compania Paulista de Cellulosa Copas, Sao Paulo.

Sweden

On the pulp market a pronounced improvement in Sweden's export position has taken place in recent months. The rising production of paper and board and also of rayon yarn has induced an increased demand for pulp of various kinds, with the result that during the Summer the sales were more lively than usual at that time of year. During the period January–July, the combined pulp exports amounted to 1,105,000 tons as against 825,000 tons during the same period of last year. On the other hand, the value of the exports fell considerably from kr 1040 million ($208,000,000) last year to kr 670 million ($134,000,000) this year. The quantitative increase related to all kinds of pulp with the exception of viscose cellulose, which showed a decline from 183,000 tons to 167,000 tons. It is essentially the American market that has accounted for the increase in exports this year. During the first half of the year, the exports to the United States were three times as large as in the first half of 1952. It is now estimated that the exports to that country this year will be around 300,000 tons, compared with just under 200,000 tons in both 1951 and 1952.

Sweden's exports of paper and board during the first 7 months of the year amounted to 387,000 tons, thereby exceeding the exports in the same period of last year by 64,000 tons or 20%. The value of the exports, on the other hand, dropped heavily—from kr 461 million ($92,200,000) to kr 339 million ($68,000,000) or by 26%.

Finland

The Soviet Union took about 25% of Finland's foreign trade in the first 6 months of this year. About 42% of Finland's total deliveries to Russia were comprised of products of her wood industries, including 400,000 cubic meters of pulpwood (113,000 cords), 16,000 metric tons of cellulose, and 12,000 metric tons of groundwood.

Finland's State Planning Board has recommended to the Finnish government that it allocate 4,000,000,000 Finnmarks (U. S. $17,315,000) for subsidizing chemical pulp exports. The money would be obtained from the Wood Industries Equalization Fund, which was secured by a levy on the export of wood products during the Korean boom.

Tree Breeding

Forest tree breeding is of exceedingly great importance to Finland whose economy is predominantly based on the yield of forests.

Methodical forest tree breeding was introduced in Finland in 1947 with the establishment of the Foundation for Forest Tree Breeding to organize and supervise the work. The founders and supporters of the Foundation include all the various circles interested in forestry: the state, forest indus-

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Annual meetings of both the American Paper & Pulp Association and Technical Association Pulp & Paper Industry held in February in New York City.

The APPA will be meeting at the Waldorf-Astoria on the dates of Feb. 15, 16, 17, 18. TAPPI will hold its annual convention concurrently at the Hotel Commodore.

Paper & Pulp Products Convention Dailies are REAL newspapers. They give all the news, programs, events and general information of association meetings. They reach the thousands of paper men attending these important conventions. Daily on-the-spot service that is typical of Paper & Paper Products.

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try, private forestry organizations, and private persons The Foundation works in particularly close cooperation with the Forest Research Institute whose research program includes forest genetics. To date the Foundation has largely utilized the existing establishments, nurseries, and experimental areas of the Forest Research Institute in the various parts of the country.

The research and experimental activities of forest tree breeding proper are centralized in the Ruotsinkylä Breeding Station, some 25 kilometers from Helsinki. Built in 1948 the Station comprises hothouses, a cone extractory, laboratory, working rooms and storages, and a nursery. Another prominent center of breeding activities is situated at Punkaharju, some 300 kilometers northeast of Helsinki. In addition, work goes on in several nurseries in different parts of the country.

The first step in starting tree breeding is to choose the so-called plus trees which will serve as the basic material for breeding. By plus trees is understood trees chosen for their hereditary properties from stands in the various parts of the country, known to be good, of rapid growth and of particularly good quality. The selection has been very strict. To date a total of some 1000 plus trees has been chosen, including approximately 500 pines (*Pinus silvestrips*), approximately 200 spruces (*Picea excelsa*), approximately 100 birches (*Betula* sp.), approximately 100 larches (*Larix* sp.), and some 100 trees of other species. The work of selection, which continues, has extended to cover practically the whole of Finland, even beyond the Arctic Circle. The plus trees are measured in detail and marked off in the terrain.

In the late Winter and Spring top branches of plus trees are collected for grafting, which is made in hothouses in March-April and out-doors in May-June. The branch taken from a plus tree is grafted to a seedling, or stock aged 2 to 4 years, this gives the branch a "borrowed" root system. The first graftings were made in 1949, since when a total of over 25,000 graftings has been made. The average percentage of successful graftings has been approximately 70.

A number of the grafts of each plus tree is utilized for the establishment of special tree collections for future crossing experiments. Special tree collections are situated in the neighborhood of the breeding places proper. However, the majority of the grafts are utilized for the establishment of seed orchards.

The term "seed orchard" refers to a stand raised exclusively for the production of forest tree seed. It is usually approximately 3 hectares in size and contains 25 grafts from each of 25 plus trees, i.e., a total of 625 grafts. The grafts are planted with 7-meter spacing, by a special lotting system, evenly mixed throughout the whole seed orchard area. To insure pollen isolation seed orchards are established in places where none of the tree species concerned grow within a minimum radius 0.5 kilometer, and in a climatic district where the ripening of the seed is favored as highly as possible i.e., primarily in the southern half of Finland. This is of great importance in meeting the seed requirements of North Finland where, due to the cold climate, tree seeds seldom ripen.

Seed orchards aim at producing seed for reforestation of as high a genetic standard as can possibly be achieved at the moment. In addition, seed orchards make for more rational seed collection, and they produce seed physiologically superior to the seed obtained earlier.

Seed orchards are established at the order of various forest owners. At the moment over 30 seed orchards are in the process of establishment, approximately half of them are pine seed orchards, the remainder being evenly divided between spruce, larch, and birch. Seed orchards have been ordered primarily by woodworking companies, the state, and the organizations of private forest owners.

In addition to seed orchard work for practical ends, research and experimental activities are also carried out. The most successful have been the different crossing experiments. Among them may be mentioned the cross of *Populus tremula* and *P. tremuloides*, experimentally planted in various parts of the country, furthermore, birch crosses and especially larch crosses have been produced, with results that seem very promising. Research and experimental activities, in view of the nature of the matter, are still so new that no final results can be shown.

Forest tree breeding in Finland is only 6 years old. The work has gotten off to a good start, and gradually perhaps the position will be reached where all artificially regenerated forests will derive from seed of a high genetic standard, continuously improving with time. This means for the future a higher yield and better quality timber from our forests.

Australia

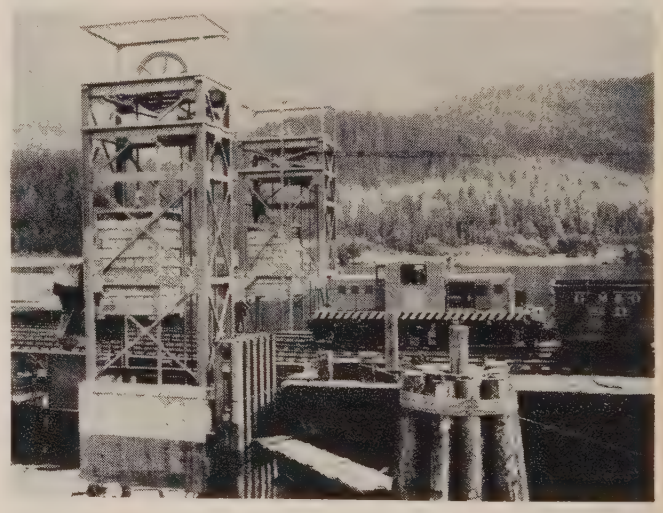
Australian Paper Manufacturers Ltd. announce that their technical control staff has been regrouped for more direct study of the company's products. Competition from imported products has added impetus to the drive for improved quality, and inspection and control have been intensified and improved by the use of new equipment.

New Zealand

Scheduled to begin operations soon, the new Kinleith mill of New Zealand Forest Products Ltd. will be the first mill in New Zealand to manufacture paper entirely from home-grown trees.

Alaska

The beginning of industrial expansion in southeastern Alaska was marked recently by the arrival of the first locomotive



Arrival of first locomotive and railroad cars purchased by the Ketchikan Pulp Co. of Ward Cove, Alaska

and railroad cars, purchased by the Ketchikan Pulp Co., Ward Cove.

Israel

Construction of a $4,000,000 plant for American Israeli Paper Mills Ltd. at Hadera, Israel, by Merrit-Chapman & Scott Overseas Inc. (a subsidiary of Merrit-Chapman & Scott Corp., New York) has been completed, it is reported in the current issue of *Economic Horizons*, monthly publication of the Jewish Agency's Economic Dept. in New York.

Major American investors in the new mill which will supply half of Israel's paper needs include Joseph Mazer, Treasurer of Hudson Pulp & Paper Corp., New York, and the Palestine Economic Corp., New York. The venture is open to further capital participation.

Something New in Sizing

KELGIN XL, a new development in paper surface sizing, can be applied on either the calender stack or size press as a 0.75% - 3.5% solution. It effectively increases surface density, develops finish and improves smoothness. High gloss mottle-free printing at substantially reduced ink costs. KELGIN XL sizing effectively increases grease resistance of paperboard and glassine stock.

If you have sizing problems in one of these applications, ask your nearest Kelco office to send a Kelco technical paper representative to demonstrate the advantages of KELGIN XL.

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Machinery and equipment for the plant were purchased in the United States, Scotland, and Belgium. Highly skilled Scotch and Italian labor has been recruited to work in the plant and train Israelis. Management will be under the direction of Robert W. Zion, a Hudson executive. Operations are scheduled to begin this month. The line will include kraft paper for cement bags, newsprint, stationary, and printing paper.

The mill's pulp requirements will be supplied from Finland under the terms of the Israel-Finnish trade agreement. An initial stockpile is already at hand.

Korea

"Chosen, the Hermit Kingdom" which today we call Korea was not always a tragic, war-torn, bleeding land. Despite centuries of foreign rule—in some ways, because of them—Korea was once a bubbling spring of culture and progress and contributed much toward the spreading of papermaking techniques throughout the Orient, Middle East, and Europe.

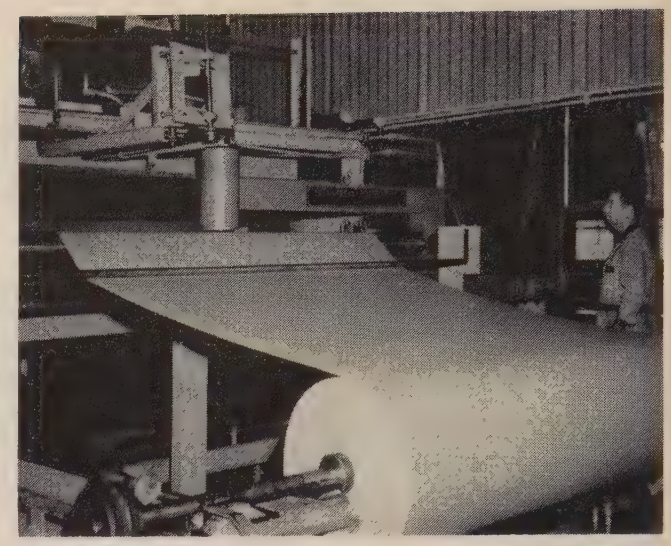
In the early days, contact with the mainland was close; as soon as the Chinese courtier Ts'ai Lun discovered a method of making true paper in 105 A.D., the secret art spread out along the peninsula and numerous small papermaking establishments arose in Korea. The process was the same as in China, mulberry bark (usually) was soaked and the inner skin peeled away for beating and pouring on a cloth stretched over a bamboo frame. At first the paper sheets were sun-dried on the screen, later, after the vatmen learned to dip their molds, the sheets were couched and then hung to dry on lines in the sun or dried against heated brick or plaster walls. As Japanese influence increased, a few Japanese refinements were added and Korean paper became stronger. The mulberry bark was boiled in a glue of *tororo-gusa* root until the fiber-bundles dissolved. New raw materials were introduced, such as *gampi*, a wild tree whose bark made paper that was impervious to bookworms, *mitsumata* (*Edgeworthia papyrifera*), rice straw and bamboo. The Korean mold was always $28^1/_2 \times 46^1/_2$ in. as multiples of this size were adaptable to the paper's primary use: oiled floor coverings.

A simple chronological list of Oriental achievements in which Korea initiated new methods or was instrumental in their spread throughout the world will show Korea in favorable comparison with Western progress.

A.D.		
	286	Atogi, Prince of Korea, taught written characters and literature (Chinese) to Japanese.
	610	Dokyo (or Doncho) a Buddhist monk, brought the first sheets of paper to Japan from the King of Korea.
	770	First text printing on hemp paper, from blocks. This job consisted of 1,000,000 *dharani* (prayers) with paper pagodas to match each and took 6 years to complete. None of the blocks have ever been found so it is not known whether they were of wood, metal, stone, or porcelain. (Japan; Korean technicians.)
	807–75	First printed books (from blocks); first paper money, called "flying-money" and first toilet paper. All these Sino-Korean-Japanese innovations were centuries in advance of their Western counterparts.
	1041–49	Invention of movable type by Chinese Pi Sheng; quickly introduced and used in Korea. (*Europe's first movable wooden type was cut in Haarlem, Holland around 1438.*)
	1403–09	King of Korea ordered establishment of type foundry. First movable metal type was produced and first book was printed from movable metal type. (*Gutenberg's 42-line Bible was printed in Mainz, Germany, 1450–55.*)

Formica

A combination of the three most recent developments in modern production control—utilization of nuclear energy, electronic computing, and automatic controls—is providing the Formica Co. of Cincinnati, Ohio, with greatly improved control of the difficult paper-impregnating process.



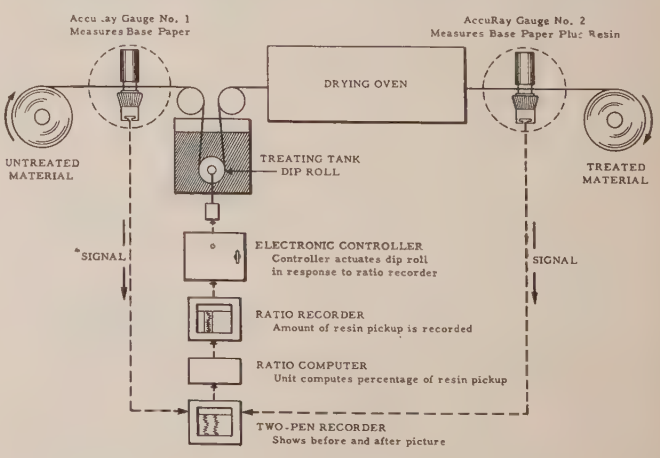
AccuRay nuclear gage is shown measuring base paper before it enters chemical bath. Machine operator stands before gage consoles which chart amount of resin being put on paper

Long a headache to technical men in the plastic-laminate industry, the problem of accurately controlling the amount of resin impregnated into various base papers on a continuous run basis has been solved by Formica with their new setup.

First of its type in the industry, the installation was designed and supervised by specialists of the Industrial Nucleonics Corp., Columbus, Ohio. The new system integrates into the impregnation line two AccuRay beta gages—actuated by radioisotopes—a ratio computer, and an automatic electronic proportional controller.

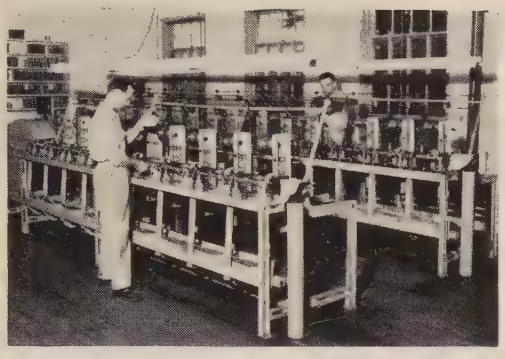
Nuclear gaging is fast, reliable, and super-accurate, permitting automatic production control for the first time. The two gages continuously read the weight of the base paper before impregnation and the total weight after impregnation on a line that travels 100 f.p.m. These readings are analyzed by a computer and fed to an automatic controller which adjusts the process machinery when necessary.

The AccuRay gages, manufactured by Industrial Nucleonics, automatically compensate for environmental factors such as temperature changes, humidity, dust, and other influencing factors. They do not contact the moving sheet at any time. In each gage, a hermetically sealed capsule of radioactive strontium 90 emits beta rays. These rays are beamed upward through the moving material being measured and the rays that penetrate the measured material are collected in a special type of ionization chamber located on the arm of the

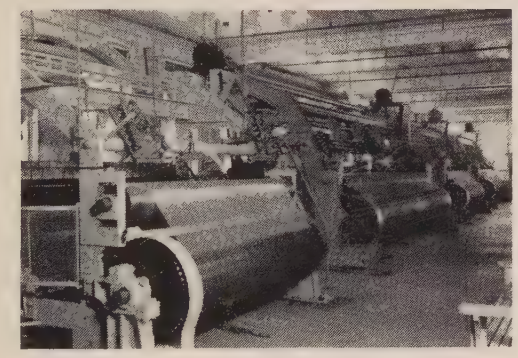


Schematic plan of the Formica control system

be WIS-WISE *use*
Perfect Surface
WIRES *for perfect performance*



1. Corner winding dep't.



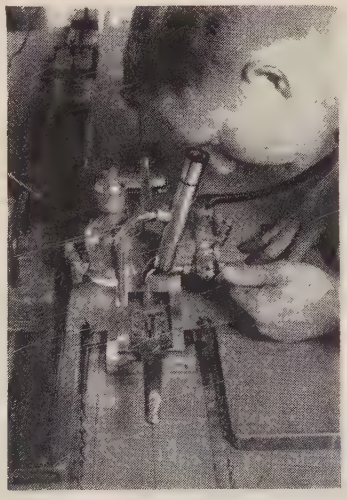
2. View showing looms in one corner of weaving dep't.

3. Stretching and inspecting completed wire.

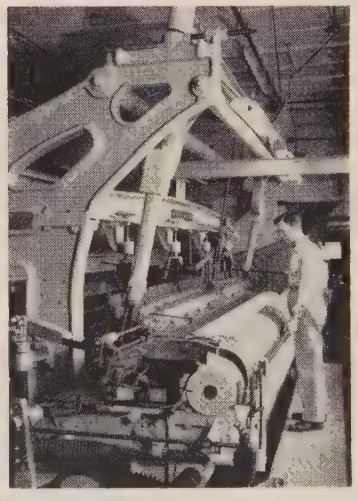
Far away from woodlands of North and South . . . out in the barren copper country of the West . . . is the birthplace of fourdrinier wires. From this copper is drawn the perfect wire that is woven into our wires by expert craftsmen and the most modern equipment.

Years and years of experience is your assurance of the best when you use *Wisconsin Perfect Surface Wires.*

If you have not as yet seen our color film "WEAVING WISCONSIN WIRES" we will be pleased to send it to you. After viewing this film you will know why *Wisconsin Perfect Surface Wires* are not excelled in the manufacture of paper.



4. Showing seaming of Wisco fourdrinier wire.



5. Modern power loom being operated by skilled wire weavers.

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... Here's a Solution!

Just add Magnus Beatex at the beater. You'll find dirty, inky, waxy ingredients in the furnish easy to disperse.

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HIGH-WETTING
MAGNUS BEATEX

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Service Representatives in Principal Cities

gage above the sheet. The amount of radiation passing through the material is directly proportional to the weight of the material. Because the gage is calibrated, variations in radiation cause changes in signal that vary directly with change in weight per unit area. These changes are penned on a strip chart recorder, giving a continuous, direct weight reading at all times and presenting a permanent record of each run.

PARSONS AND WHITTEMORE

Parsons & Whittemore, Inc., New York City, has just contracted to build an approximately $6,000,000 mill in the east central area of Brazil for manufacturing prime bleached pulp for the pulp and paper industry, it has been announced by Karl F. Landeggar, president. Import and export licenses for the machinery and equipment have been approved.

The new Brazilian mill, with a capacity of 50 tons of bleached pulp per day, is being built for Compania Paulista de Cellulosa Copas, Sao Paulo, Brazil, and will be the first mill in Brazil to make pulp from eucalyptus wood only. There are only two other mills in Brazil, each of which primarily makes pulp from pine.

The new mill will be a completely self-contained unit, including not only the normal pulp machinery and equipment but a complete electrolytic plant. This plant will produce sodium hydroxide and chlorine, the basic ingredients used in bleaching and cooking eucalyptus pulp as employed by this mill.

The eucalyptus pulp will be used in making writing, printing, bond, book, and other types of paper.

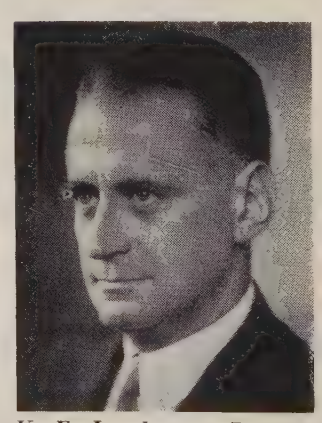
The Brazilian mill is being built under Parsons & Whittemore's "Private Point IV" program, announced early this year, which facilitates the construction of pulp and paper mills in underdeveloped countries of the world. Each mill is designed to make pulp and paper from raw materials indigenous to the country in which it is built.

It is also announced that the Parsons & Whittemore-Lyddon organization has sold a large high-grade paper machine, manufactured by J. M. Voith of Germany, to S. A. Industrias Reunidas Matarazo, Sao Paulo, Brazil, and a complete modern tissue papermaking machine, manufactured by its affiliate Millspaugh, Ltd., Sheffield, England, to Cia Fabrica de Papel Petropolis, in Petropolis, Brazil. The Matazaro machine is already in operation, the other will be in operation before the end of the year.

Black-Clawson Co. of Hamilton, Ohio, the American Machine manufacturing affiliate of Parsons & Whittemore, is also completing this month a new board machine mill in Fiskeby, Sweden.

HUDSON

Charles Grondona, vice-president of Hudson Pulp & Paper Corp., announces his resignation from the corporation effective immediately.



K. F. Landeggar, Parsons & Whittemore, Inc.

Charles Grondona

Mr. Grondona's most recent assignment has been supervising the design and construction of the American Israeli Paper Mill in conjunction with the Merritt-Chapman, Scott Corp. It is expected that upon the completion of this modern mill in Israel, Mr. Grondona will make a further announcement regarding future plans.

Charmin

The 1953 financial report of Charmin Paper Mills, released last July, was judged the best for the year in the paper products industry in a contest sponsored by *Financial World*. The Charmin Mills have entered the competition in past years, but this marks the first time the firm has won a bronze "Oscar of Industry" trophy. The award will be accepted by J. M. Conway, president and general manager, at the annual awards banquet to be held late this month at the Statler Hotel, New York City.

In the same industrial classification as Charmin Mills, Sonoco Products Co. was runner-up for top honors, while the Union Bag & Paper Co. placed third.

Gair

In the final ratings of the independent board of judges in the thirteenth survey of 5000 annual reports, conducted by *Financial World* magazine, Robert Gair Co., Inc., New York, was judged to have the best annual report of the paperboard container industry. The bronze "Oscar of Industry" trophy will be presented to the Gair Co. at the magazine's annual awards banquet on October 26.

N. Y. and Pennsylvania

A new semichemical pulp pilot plant has been completed at Lock Haven, Pa., for the New York and Pennsylvania Co., Inc., by The Rust Engineering Co.

The new facility was designed to make use of Pennsylvania hardwoods for producing pulp to be used in the high-grade paper manufactured by the company. The pilot plant can also utilize local softwoods.

The project included design and construction of a two-story concrete and cement block building, as well as a wood handling system, pulp mill, and bleach plant.

While experimental in nature, pulp production of the new mill can be integrated with the New York and Pennsylvania Co.'s other units at Lock Haven consisting of two paper mills and a pulp mill.

Parsons

In celebration of its 100th Anniversary this year the president of the Parsons Paper Co. of Holyoke, Mass., Edward Parsons Bagg, Jr., M.D., has written a company history called "A Century of Papermaking." Dr. Bagg is the grandson of the company's first president, Colonel Aaron Bagg of West Springfield, nephew of the company's second president, Aaron Bagg, Jr., son of the third president, and brother of the fourth and fifth presidents, Aaron C. Bagg and John L. Bagg.

Aetna

Plant additions now completed at Aetna Paper Co. Div. of Howard Paper Mills, Inc., Dayton, Ohio, pave the way for a 30 to 35% boost in production and a 15 to 20% increase in factory personnel.

J. E. Minch, vice-president and director of sales for all Howard divisions, said, "The $1,000,000 development program includes 61,000 sq. ft. of factory space and a new papermaking machine." Minch said the new facilities also would include a new modern laboratory to handle a greatly increased program of research and technical control for the four Howard divisions. Besides Aetna, Howard Paper Mills, Inc., includes the Howard Paper Co. Div., in Urbana, Ohio, the

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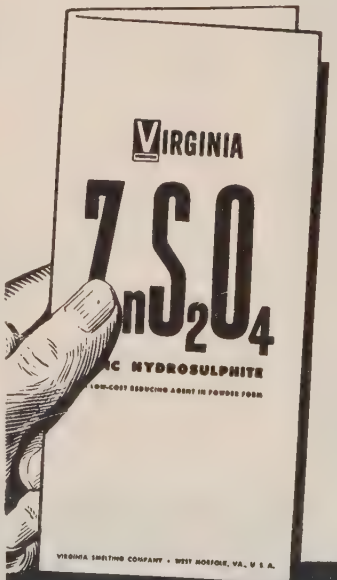

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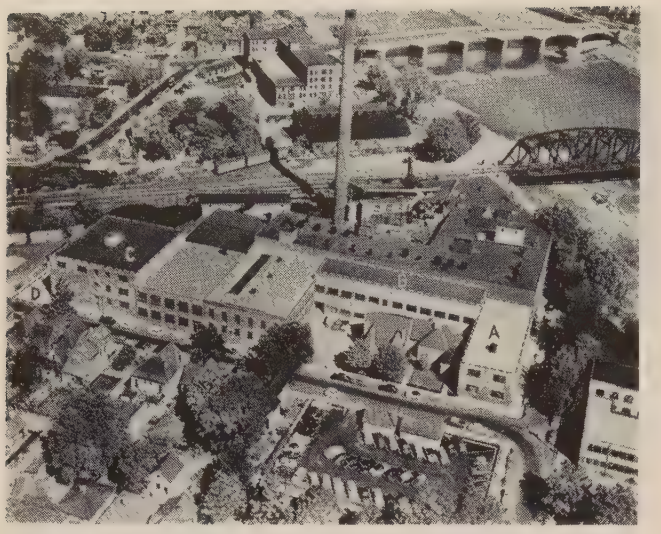


Aerial view of Aetna Paper Co., showing new plant additions to house: (A) rag pulp conversion; (B) new papermaking machine; (C) finishing and technical research; and (D) truck loading and shipping facilities

Maxwell Paper Co. Div., in Franklin, Ohio, and the Dayton Envelope Co. Div., also of Dayton.

Aetna papers include extra fine rag content papers and high-grade sulphite papers. One of the new sections of the plant will be devoted to rag pulp conversion.

Arkell and Smiths

Arkell and Smiths, multiwall bag manufacturer, with headquarters at Canajoharie, N. Y., was recently issued a patent covering a special valve formation on pasted multiwall bags used for hydrated lime and other finely pulverized materials. The valve, designed to reduce sifting, has been trade-marked under the name of "Lock-Rite." The patent names Jom Jones, who joined the Arkell and Smiths staff in 1947 at Columbus, Ohio, as the inventor. Mr. Jones was appointed central division sales manager in 1951, with supervision over the central states area. The issue of the patent was reported recently by Sheldon Y. Carnes, vice-president and general sales manager of Arkell and Smiths.

Bergstrom

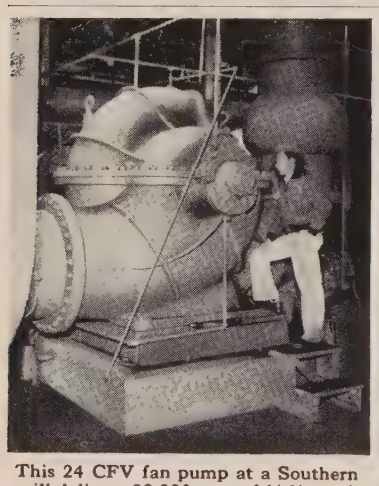
Foster P. Doane, Jr., production manager of the Bergstrom Paper Co., announced recently the appointment of Richard M. Elias as mill superintendent to fill the post left vacant by the recent death of Thomas W. Seidel. Mr. Elias, formerly assistant superintendent, is a graduate of Lawrence and did graduate work at The Institute of Paper Chemistry. He has been associated with Bergstrom Paper Co. since 1949.

Maurice H. Larson has been promoted to the position of assistant superintendent. Mr. Larson came with Bergstrom Paper Co. in 1923. Since then, he has had experience in all phases of the papermaking operation.

International

Two major sales divisions of International Paper Co. have been consolidated into a single operating unit, to be known as the Fine Paper and Bleached Board Div. Headed by Lamar M. Fearing, sales manager, the new division will include the former Book and Bond Div. and the Groundwood Specialties Div., and will be subdivided into three major sections, each headed by an assistant sales manager.

Paul A. Mahony, formerly sales manager, Specialties Div., has been appointed assistant sales manager and will be in charge of Product Development and Mill Coordination for the entire new division.



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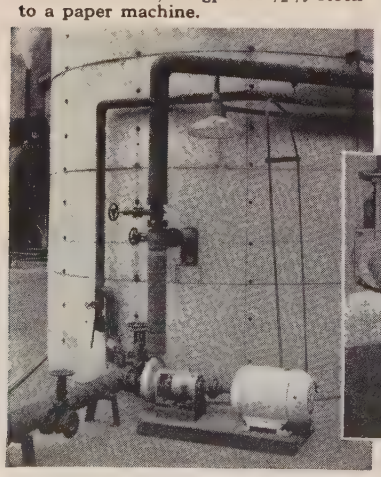

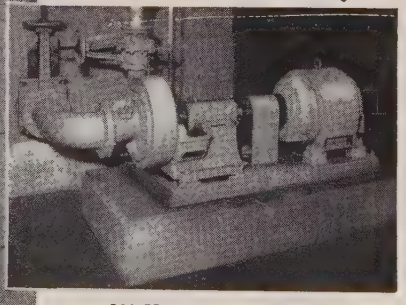

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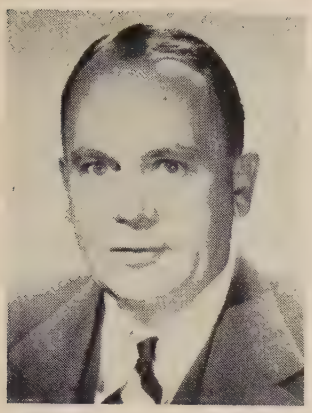
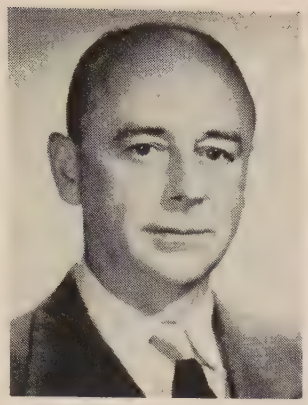
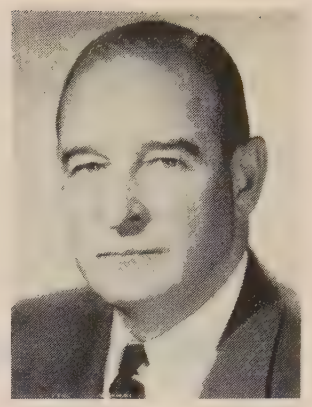


L. M. Fearing, International Paper Co.



P. A. Mahony, International Paper Co.

J. H. Goodwin, International Paper Co.



W. K. Graves, International Paper Co.

All of the converting grades formerly handled by the two sales divisions will now be brought together under John H. Goodwin, assistant sales manager, who formerly was assistant sales manager of the Book and Bond Div. He will also continue some of his present activities in the writing and book paper fields.

The third major subdivision, Merchant Sales, will head up under Wallace K. Graves, assistant sales manager, who formerly was manager of the New York sales office.

The present Boston, Cleveland, Chicago, and New York Sales offices will continue their operations under the new division. Larrence E. Graham has been appointed manager of the New York sales office. In addition, Wyndham R. White has been appointed sales representative for the southern states, H. Clay Mangles, Philadelphia representative, and Edward Bailey, Pacific coast representative.

In order to coordinate this division's activities in the publication field, John P. Sawyer has been placed in charge of publication sales. In this assignment he will direct national sales to all magazines and other periodicals.

The appointment of Howard D. Gerring as manager of the Kalamazoo plant, Single Service Div., International Paper Co., has been announced by C. Soutter Edgar, division manager.

The Kalamazoo plant, which was opened early in 1951, has a monthly capacity of 90,000,000 Pure-Pack paper milk containers and employs 260 men and women.

International Paper Co. has begun construction of a $2 million expansion and modernization program at the company's Camden, Ark., paper mill. The current expansion plan includes a new cooking plant, enlargement of a finishing room, and the modernization of a paper machine. The company

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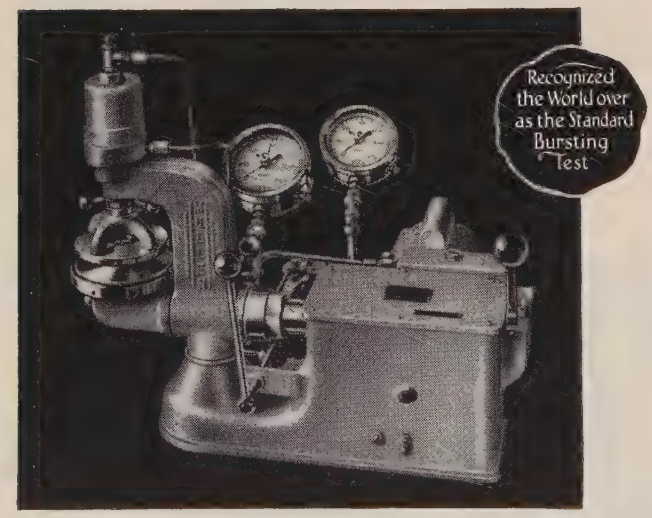

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also plans to build a new personnel office, a new time building, a new bathhouse for workers, and a new employee parking lot.

RAYONIER

The appointment of B. W. Haskell as resident engineer of the Fernandina Div. of Rayonier Inc., producers of chemical cellulose, was announced by Fred B. Doherty, resident manager of the Fernandina Div.

Mr. Haskell joined Rayonier in February, 1946, as staff engineer. Prior to that time he was employed with the General Electric Co. He served in the U. S. Army Ordinance and Air Force in the European Theater during World War II and attained the rank of Captain.

Mr. Haskell is succeeding William C. Rindsland who is transferring to the position of resident engineer of the Jesup, Ga., Div. of Rayonier.

Mr. Rindsland has been associated with Rayonier as resident engineer of the Fernandina, Fla., Div. since August, 1952. His career includes experience as a professor in the College of Engineering, University of Minnesota, in addition to wide experience as an engineer with Appraisal Service Co. and Minnesota and Ontario Paper Co. at International Falls, Minn.

BIRD

Construction of Bird & Son's $2,250,000 Roofing Plant at Charleston, S. C., is under way. Ground-breaking ceremonies took place on Wednesday afternoon, September 2, at Stark Industrial Park, Charleston, with President A. H. Anderson wielding the symbolic gold-painted shovel. Other Bird & Son officials present at the ceremonies were Vice-President Eli L. Chamberlain, Secretary-Treasurer Wesley C. Ahlgren, William R. Wright, Jr., superintendent Norwood Roofing Plant, David Fleming, chief engineer, Sales Manager J. H. Van Hoy, and salesmen B. L. Sears and J. B. Blandford.

The new Bird plant will house a modern roofing machine 500 ft. long, the longest machine in the country. It will have all the latest refinements for producing a full line of asphalt shingles and roll roofings, as well as plastic cements and roof coatings. The plant is being built on a 48-acre site purchased by Bird & Son at Stark Industrial Park on the Ashley River. It will employ 150 people and is expected to be in operation by next summer.

BEMIS

A paper specialty plant will be constructed in Crossett by the Bemis Brothers Bag Co. of St. Louis, C. F. Tatum, president of the Crossett Industrial Foundation, and A. H. Clark, vice-president of the Bag Company, said in a joint announcement. The new plant will manufacture such items as liners and covers for the packaging fo objects of unusual size and shape. These liners and covers will be made from kraft paper.

The Bemis Bag Co. produces cotton, paper, and burlap bags in plants in 17 states. No other Bemis Bag plant is located in Arkansas.

WEST VIRGINIA

West Virginia Pulp and Paper Co. has announced the formation of a new division to broaden the commercialization of its lignin products. The division will be under the direction of Paul Wiley, who has been director of the company's Development Dept. at Charleston, S. C., since 1947. The new organization begins its operations immediately and will be known as West Virginia Pulp and Paper Co., Polychemicals Div.

The new division will be located at Charleston, S. C., and its activities will embrace all phases of lignin operations, including production, product and uses development, sales, and administration. The personnel will be drawn largely from

members of the Charleston Development Dept. who have long been associated with lignin.

Stockholders of West Virginia Pulp and Paper Co. have approved a plan to acquire the Hinde & Dauch Paper Co. as a subsidiary through an exchange of stock.

As prerequisites for the exchange offer to Hinde & Dauch, the stockholders also approved proposals to reclassify and split West Virginia's common stock.

A total of 834,257 of the 903,482 shares of West Virginia's outstanding common stock was represented at the meeting, either in person or by proxy, and more than 99.9% of the shares voted were in favor of the proposals considered.

Plans call for Hinde & Dauch to be operated as a subsidiary of West Virginia, with the operations, personnel, and customer relationships of the two companies unchanged. Sandusky, Ohio, will continue to be headquarters of H. & D. The main offices of West Virginia Pulp and Paper Co. are in New York.

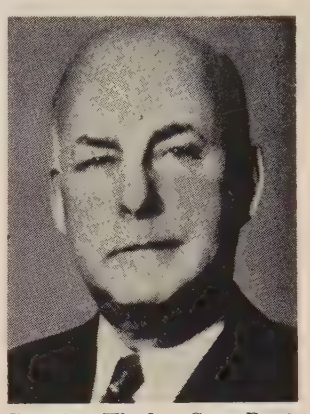
Hinde & Dauch now operates 12 box factories, in the United States producing close to 3,000,000,000 sq. ft. of board products per year, and five paperboard mills producing well over 80,000 tons per year. Hinde & Dauch reported net sales of $43,118,000 for 1952 and net earnings, after taxes, of $3,132,000. For the first 6 months of 1953 net sales amounted to $24,017,000.

West Virginia owns and operates six mills in five states, with a capacity of more than 800,000 tons of paper and paperboard per year, and owns and manages about 750,000 acres of timberlands, located mostly in North and South Carolina. Net sales in fiscal 1952 amounted to $108,933,000, for a net profit of $9,471,000. During the first 9 months of fiscal 1953 West Virginia's net sales amounted to $85,638,000.

In Canada, Hinde & Dauch owns a majority interest in Hinde & Dauch Paper Co. of Canada, Ltd., which owns and operates three paperboard mills with an annual capacity of 100,000 tons, and three box factories with a production of about 1,000,000,000 sq. ft. per year. West Virginia owns and operates a partially integrated corrugated container plant in Brazil, which manufactures and sells about 30% of the corrugated boxes made in Brazil and produces part of its requirements of pulp.

St. Regis

Thomas A. Wark, resident manager of St. Regis Paper Co.'s mill at Sartell Minn., retired on October 31 after more than 50 years in the paper business. He continues to serve in an advisory capacity.



T. A. Wark, St. Regis Paper Co.

In his more than half a century of papermaking, Mr. Wark has been associated with more than a dozen of the leading paper manufacturers throughout the United States and Canada, as well as with one Norwegian manufacturer.

William S. Woodward succeeds Mr. Wark as resident manager of the Sartell mill.

Mr. Woodward joined the Watab Paper Co. in 1933 and served in the military forces from May, 1942, to the end of 1945. The Watab mill (now the company's Sartell mill) was acquired by St. Regis late in 1945. When Mr. Woodward returned from military service, he was transferred to the company's Little Falls mill and continued with the new owners of

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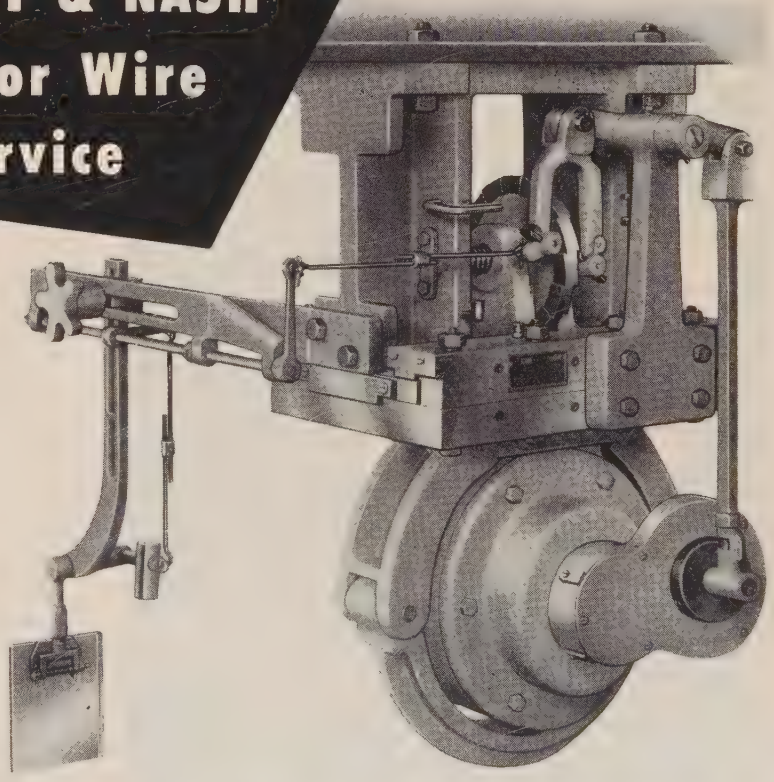

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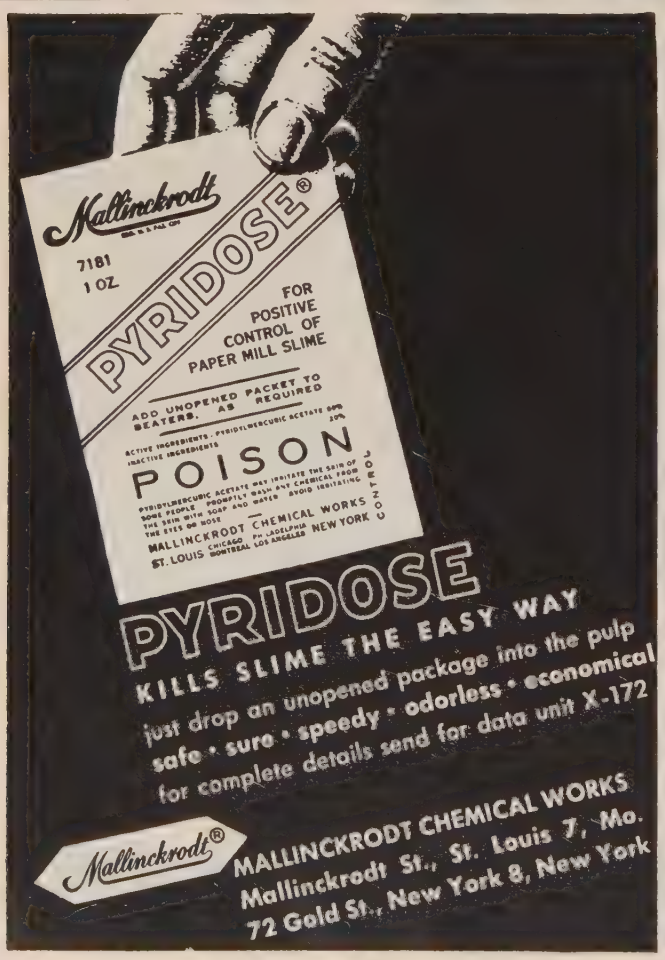
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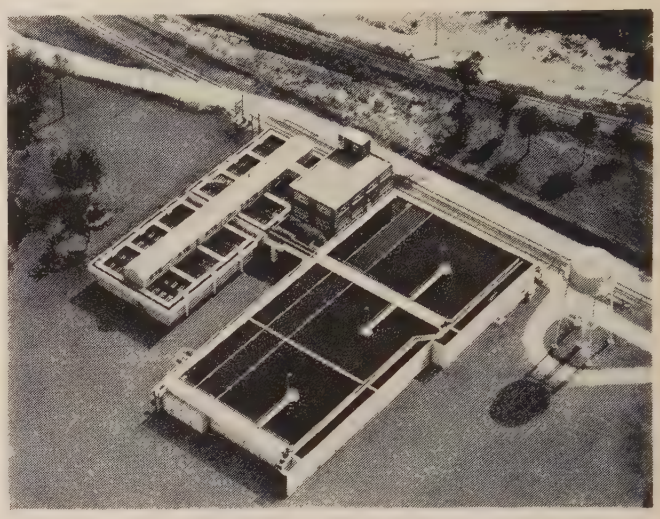
that mill when it was sold in the middle of 1951 until he rejoined St. Regis at the Sartell mill on September 30 last.

St. Regis announces the sale of the company's Harrisville, N. Y., paper mill, including real estate and inventories, to the Harrisville Paper Corp.

Hollingsworth & Whitney

The Hollingsworth & Whitney Co. has recently expanded the water treatment plant at its Chickasaw Mills, Mobile,



The new water treatment plant at the Mobile mill of Hollingsworth & Whitney Co.

Ala., by adding two Dorrco Flocculators and Squarex Clarifiers, as well as additional filter capacity. Two Dorrco Flash Mixers are used for mixing alum and lime as coagulants.

Union Bag

Scheduled to go into production soon is a new semichemical pulp mill at the Union Bag & Paper Corp's mill in Savannah, Ga. Designed to utilize gum wood, the new mill is expected to use about 300 cords of wood per day, and will step up the mill's production of kraft paper and paperboard to 1800 tons per day.

Keyes Fibre

In celebration of its 50th anniversary, Keyes Fibre Co., Waterville, Me., held open house for families of employees on Sept. 22–24. Approximately 3900 people toured the Waterville and Shawmut plants during the anniversary observance, arrangements for which were in charge of John S. Parsons, assistant to the general manager. Assisting Mr. Parsons were: John H. White, E. B. Denton, R. L. Emery, Ralph Wescott, Richard Hawkes, Robert Brown, and Lloyd Cutting.

Nepco

Nekoosa-Edwards Paper Co., Port Edwards, Wis., has honored the memory of L. M. Alexander, pioneer of the Nepco, by the erection of a bronze plaque in the new machine room.

Robert A. Petry has been named assistant manager of Woodlands operations for Nekoosa-Edwards Paper Co., Port Edwards, Wis., effective October 1.

Nekoosa-Edwards is experimenting with soda-base sulphite pulping. About 500 tons of pulp have been produced by the new process, which uses a Western Precipitation Corp. recovery system. Limited success has been attained in processing the spent liquor to recover heat and chemicals.

O.B.C.

Ohio Boxboard Co., Rittman, Ohio, has made an extensive

examination of bleached kraft pulp manufactured by various companies in the United States and Canada. Purpose of the study was to enable OBC to select pulps to meet quality specifications for the company's various products, and officials of the company state that a definite improvement has been achieved.

WEYERHAEUSER

Why doesn't the construction industry use more lumber? What is the per capita consumption of paper and paperboard likely to be 25 years from now? What new forest products have the best chance to succeed in tomorrow's markets?

Since the beginning of the century lumbermen and pulp manufacturers have been vexed by a number of seemingly unanswerable questions. As the population and economy of the United States expanded, the per capita use of lumber declined and the consumption of pulp and paper products skyrocketed.

Weyerhaeuser Timber Co., in an effort to foster better general understanding of the problems and prospects of the forest products industries, has retained Stanford Research Institute, Palo Alto, Calif., to conduct an impartial and thorough study of the future demand for American and Canadian forest products. After Stanford makes its complete report to Weyerhaeuser, the firm intends to publish the results.

In announcing this unusual project, J. P. Weyerhaeuser, Jr., company president, said:

"Our firm has asked Stanford to take a long look at the future demand for lumber, plywood, pulp and paper, wood fiber products, and other forest products. We want to know the trends in construction and more about the competition, both present and future, between various building materials so that we will have an indication of tomorrow's log requirements.

"The study will go farther than merely considering the competition between wood products and materials of other industries. It will attempt to illuminate the intra-industry competitiveness, for example, of hardboards, plywood, softboards, sheathing lumber, fiberboard, containerboard, and wooden boxes.

"Stanford will attempt to predict how much of the increasing pulp, fiber, and board requirements can be met through a better integration of lumber, plywood, and pulp operations, and by industries better serving the small woodlot owner who currently hasn't much of a market for his crop."

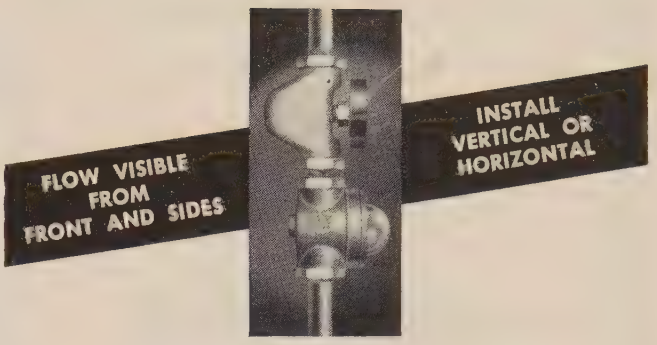
Directing the project is the institute's senior economist, A. Kenneth Beggs. His staff members have completed preliminary plans for the study, and are now going out into the field for numerous interviews and the gathering of statistics.

"To forecast the future, we must have a thorough understanding of the past," Beggs emphasized. "We are going to trace the trends of many yesterdays in the use of forest products. And, we are going to seek the underlying causes for changes in wood use. We are particularly interested in the 'whys.'"

Beggs, who directed Stanford's 1952 study of the newsprint situation in the western region of North America, expects the new project to be completed in early 1954.

In general, the study will review the consumption of each of the major forest products during the past 25 years. Then comes an analysis of current consumption patterns. Along with the information, Stanford will project the nation's general economy—population, income, and other pertinent data—for target years in the 1960's and 1970's and, in some cases, a general projection up to 2000.

In the area of lumber, plywood, and hardboards, the researchers will diagnose construction trends by contacting architects, builders, contractors, materials dealers, industry leaders, and financial centers. Other industries will be scrutinized for trends in product competition.



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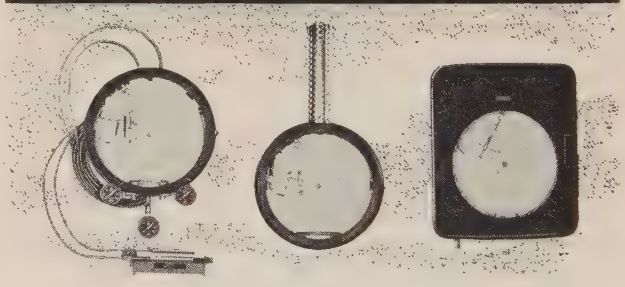

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For pulp and paper data, major pulp producers and many major paper manufacturers will be asked for information, as well as paper and board users. The rapidly growing field of fiber products, insulation board, etc., will be covered by interviews with producers and users.

The report will include data for the nation as a whole and for various regions. The Stanford group will use its forecasts of population trends, regional and national economic activity, and other data to arrive at the impact of those figures on future forest products demand.

The report will indicate what is to come in better use of sawmill leftovers. Expanding forest-industry technology for better harvesting techniques will also be looked at carefully.

MEAD

A smooth start-up featured the production of the new pulp-making facilities of the Chillicothe Div. of The Mead Corp.

Overall view of the new pulp making facilities of The Mead Corp. at Chillicothe, Ohio, taken during the late stages of construction, shows from left to right: the digester and causticizing building, the chip bin, the barking drums, woodroom, and bark burner

Pulp from the first blow in the new digester building was of fine quality, and operation during the first weeks in production indicates that a high degree of uniformity will be attained by the equipment.

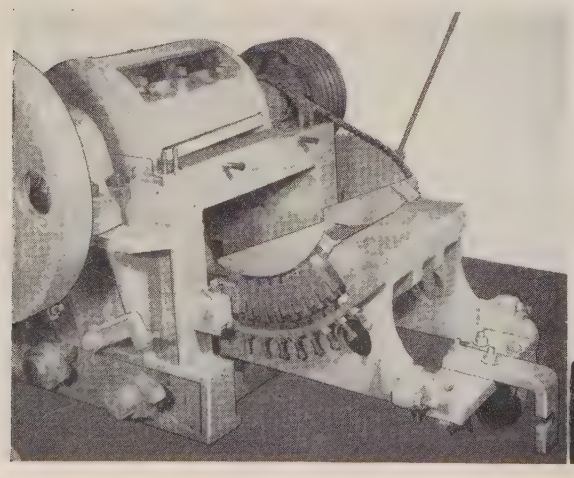
The new equipment is designed to add 110 tons of air-dry bleached soda pulp daily. It represents an important addition to the pulp capacity of the Chillicothe mill and a further step in its integration. The insulation includes a new woodyard, woodroom, digester building, brown stock washing, screen room, causticizing plant, evaporator, recovery furnace, and turbine.

Most striking feature of the woodroom, digesting equipment, and recovery system is the extensive instrumentation and automatic control provided. By means of the control systems, a small number of men can operate this entire section of the mill. Only four men per shift are required in the entire digester, brown stock washing, and causticizing building.

The new pulp mill is designed to handle two kinds of wood. In addition to the wood mix of aspen, willow, cottonwood, yellow poplar, gum, etc., that had previously been used, the mill will handle oak. Cooks of each type of wood can be made simultaneously, or a mixture of the two types of wood can be processed through the cooking process.

By using oak, Mead will be able to procure the increased quantities of wood needed for the added tonnage of the new mill from relatively near-by sources. Oak is the most abundant wood in this region. Its use not only provides the company wood for its increased requirements at a reduced transportation cost, but provides an additional source of revenue to wood producers in the area.

Engineering of the project was done by Mead's general engineering staff. Much of the construction was done by the Chillicothe Reality Co., a Mead subsidiary.



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Advantageous savings in power cost are being made by plants equipped with Taylor-Stiles multiplex cutters. These cutters are being used to reduce rags, cotton batting, waste paper, straw, and other materials before they are sent to the beater. Beater power consumption is only a fraction of that required when ALL the reduction takes place in the beater. This plan has proved its efficiency in power savings, lower maintenance cost, and improved product quality.

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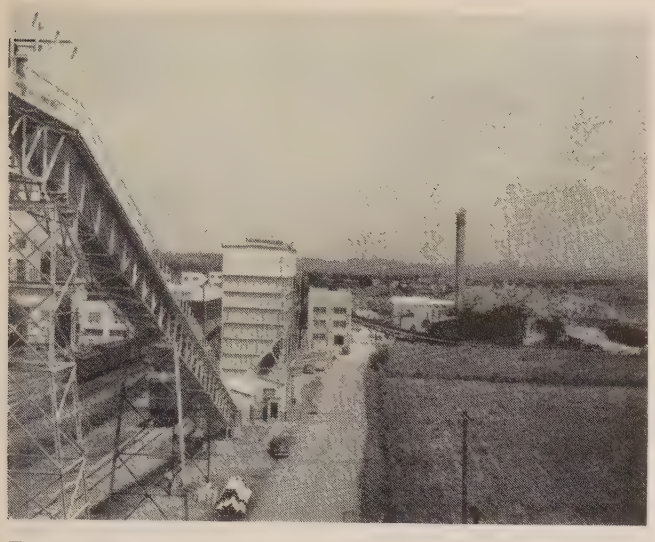

From the top of the new digester building, the Hurter-type chip bin, woodroom, barking drums, and woodyard can be seen

Wood Preparation

All wood received is 5 ft. long and from 4 to 15 in. in diameter. It comes to the woodyard in both trucks and box cars, and from either can be unloaded to storage or directly to the flume supplying the woodroom.

The woodyard stores its wood in random piles, instead of the rick storage method formerly used at Chillicothe. Two Manitowoc crawler cranes lift the wood from cars or trucks with orange peel buckets and dump it on the piles which are 76 ft. wide, 300 ft. long, and can be built up to 40 ft. high. There are currently seven storage piles in the yard, each holds about 2600 units of wood.

Wood floats from storage to the barker in a 743-ft. long flume. All unpeeled wood goes to two Fiber Making Processes barking drums, which are 12 ft. in diameter and 45 ft. long. The logs from the barkers fall onto a 6-ft. Jeffrey rubber belt conveyor where they are sorted; unbarked wood is shunted back through the drums. Barked logs go by a Jeffrey conveyor to the chipper in the woodroom. The bark is conveyed to an incinerator, where it is burned to provide heat for the flume water in the Winter, and to heat the buildings in the woodyard.

The woodroom houses two 88-in., 10-knife Carthage chippers, one of which has an extra heavy disk for handling oak wood. The chippers are driven by 400-hp. G.E. induction motors.

From the chippers, chips are conveyed to two A-C Lo-hed vibrating chip screens, and the oversize chips are fed into a Jeffrey shredder; the sawdust is burned in the bark incinerator. Accepted chips are conveyed to the top of the 68-ft.-high Hurter-type chip bin, 26 by 100 ft., made entirely of steel except for a transite-sided penthouse enclosure and a storage area at the base. It is partitioned into two sections to segregate different species of wood.

Each chip bin has an Impco twin screw feeder to deliver chips to the 42-in. Jeffrey belt conveyor below the bin. At its far end, the chips pass over a 36-in. diameter Stearns magnetic pulley, then fall onto the 42-in. Jeffrey rubber belt incline conveyor which carries them to the top of the 86-ft.-high digester building, 340 ft. distant. The woodyard, woodroom, and chip bins are designed for a 16-hr. operation. In two tricks each day, the needs of the three-trick digester operation can be supplied.

Digesters

All chips are charged to the digesters by weight, deter-

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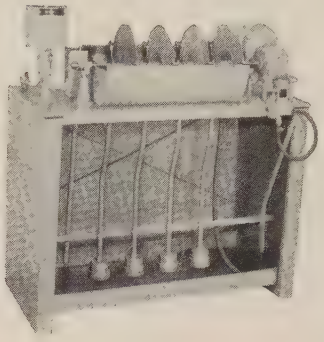

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THE JOHNSON CORP., 843 WOOD ST., THREE RIVERS, MICH.

The loading floor of the digester building of the new Mead Corp. pulp mill in Chillicothe, Ohio, showing two of the four digesters

mined by a Merrick Weightometer at the foot of the incline conveyor. When the designated weight has been furnished, the Weightometer automatically shuts off the screw feeder and the various conveyors after each has traveled far enough to discharge its load. All feeding from the chip bin, weighing, and conveying equipment is controlled from the digester room. Except for opening and capping the digesters, loading and cooking are almost entirely a push-button and instrument operation, in the new pulp mill.

At the glass-enclosed control panel on the operating floor, the digester cook selects the digester to be filled, sets the weight of chips to be supplied, selects the twin screw feeder for softwood or oak, and directs the shuttle conveyor which feeds chips received from the chip bin conveyor to the correct digester.

All machinery is interlocked, so that exact sequence must be maintained, and the interlocking system automatically shuts down the filling operation in reverse sequence when the Weightometer indicates that the correct amount of chips has been supplied. Counters on the control panel collect the total tonnage figures for wood consumed. Liquor is metered into the digester by a Foxboro automatic liquor measuring system. Amounts of white and black liquor desired are set on the control board instruments. The system supplies the correct amount to the digester, then refills the Chicago Bridge and Iron Co. measuring tanks.

The four digesters, manufactured by the Chicago Bridge and Iron Co., and 11 ft. 7 in. inside diameter and 51 ft. 10 in. from flange to flange with a nominal volume of 4600 cu. ft. They are equipped with Fiber Making Processes indirect heating and circulating systems, arranged to permit (a) direct cooking with steam, (b) forced direct cooking, and (c) forced indirect cooking. The third method is the preferred one for which the equipment was basically designed. Each digester has a 10-in. Paul blow valve, and is equipped with a Cochrane condensate removal system.

All digester instrumentation is by Foxboro and includes an automatic steaming control, flow recording of the flow in the circulating system, a modified automatic relief system, and conductivity control on the condensate from the digester heaters.

The 24-ft. diameter, 100,000-gal. below tank was manufactured by Chicago Bridge & Iron Co. An auxiliary 13-ft. diameter cyclone removes entrained black liquor from the blow steam, which then passes to a Foster Wheeler heat recovery system.

Water is heated by a direct contact heat exchanger and flows to the Foster Wheeler hot water accumulator tank for use on brown stock washers and in the Dorr causticizing plant. The heat recovery operation is automatically controlled by Brown Co. instruments.

Brown Stock Washing

Stock from the blow tank passes over two Impco preknotters and then into a two-stage Impco washing system, which has two $11^1/_2$-ft. diameter, 12-ft. face washers. The equipment has been designed so that it can be converted into a four-stage, two-drum, countercurrent washing system.

Stock from the washers is stored in a Stebbins Engineering 25-ton high-density tile storage tank, equipped with an Impco high-density dilution system for removal of stock from the chest. From this chest, the stock goes through a DeZurik consistency regulator and into the screen room. Four Trimbey screens are used. The first three are operated in parallel; these primary screens are cut 0.050, 0.055, and 0.060. Rejects from the three primary screens go through another Trimbey, which is used as a tailing screen. Rejects of this screen go to a 14-plate Impco flat screen, with 0.008-cut plates, while the accepted stock is returned to the feed of the primary screens. A fifth Trimbey screen is held in readiness as a spare.

The Trimbeys are kept loaded at all times. If the flow of stock to the screen room drops, accepted stock is automatically recycled through the screens to keep them loaded for best operating efficiency.

After screening, the pulp is thickened and bleached in equipment which was available in sufficient capacity before the new mill was constructed. It was necessary to add a 15-ton brown stock storage tank, and a 60-ton high-density bleached storage.

Recovery System

Chemical recovery begins with the collection of the weak black liquor from the brown stock washing operation. Foam

The entire digester operations, loading, cooking, and blowing are automatically controlled from control panels

on the liquor is controlled by an Impco mechanical foam breaker mounted on a Chicago Bridge and Iron 15 by 50-ft. high foam tank. From here the liquor is pumped to the thin liquor storage tank, and thence to the evaporator.

Evaporation of the thin liquor is carried out in a sextuple effect Goslin-Birmingham evaporator, which has a split feed on the fifth and sixth effects, and a two-pass liquor feed on the first effect. The evaporator is distinguished by a high degree of instrumentation. Operation of the evaporator is controlled by Foxboro instruments. A boiling point rise controller keeps a continuous check on the per cent solids in the evaporated liquor, and regulates the flow of feed liquor to keep the solids constant in the output.

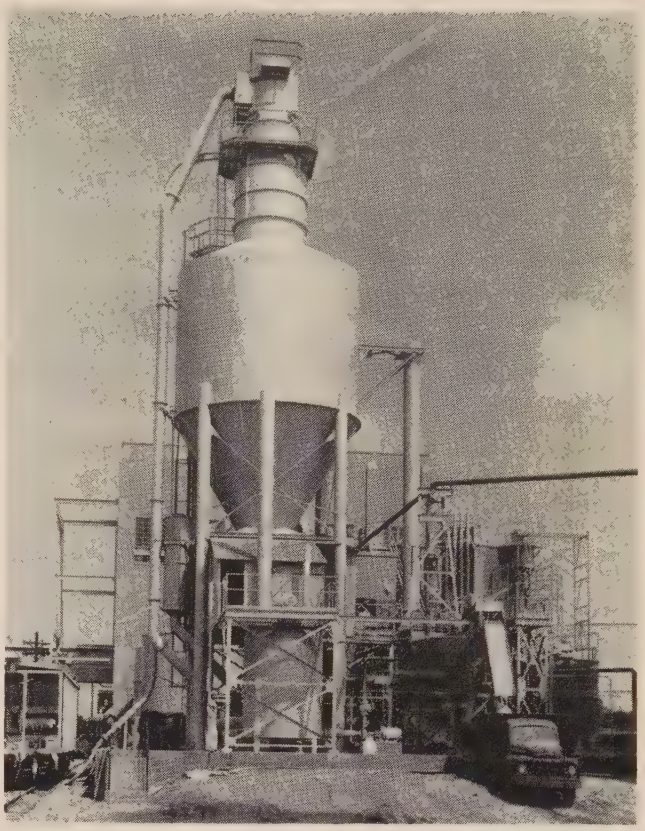
A pressure controller regulates the rate of evaporation by metering the steam going to the first effect. The split feed on the fifth and sixth effects is controlled by an instrument which apportions the flow between them on the desired basis. Temperatures at 20 different points throughout the evaporator system can be checked by means of a Foxboro Dynalog temperature indicator.

The evaporator is designed to operate with liquor containing between 12 and 55% solids, and has a design capacity of 142,600 lb. of evaporation per hour.

Condensate from the first effect is returned to the boilers, and a continuous conductivity check is maintained to prevent contamination of boiler feedwater. If a leak should develop the return valve is automatically closed, and the condensate is dumped to the sewer. Steam from the last effect goes to a barometric condenser.

The first effect is equipped with 585 2-in. 26-ft. long stainless steel tubes. Other effects each have 472 tubes, 2-in. 26-ft. long, made of steel.

The liquor from the evaporator is pumped by way of the strong liquor storage tank, to the cascade evaporator section



The lime storage tank dominates the causticizing plant where cooking liquor is made for the new pulp making facilities of The Mead Corp. at Chilicothe, Ohio

In the foreground of this view of the new pulp making facilities of The Mead Corp. is the Hurter-type chip bin. The enclosed rubber belt conveyor carries chips from the bin to the top of the digester building in the background

of the Combustion Engineering recovery boiler, where the solids are built up to 72–75% by the action of the hot flue gases from the furnace; in the process the gases are cooled from 460 to 260°. The flue gases go through a Research Corp. electrostatic precipitator equipped with a wet bottom. The recovered soda ash drops into a weak caustic wash liquor solution from the Dorr causticizing plant; this is fed into the smelt dissolving tank of the furnace.

From the cascade evaporator, the liquor goes through primary and secondary heaters and into the furnace. The capacity of the boiler is rated at 525,000 lb. of black liquor solids per 24 hr. About 1,710,000 lb. of steam at 875 p.s.i. and 825°F. are produced in 24 hr. at design rating.

The boiler is of the two-drum bent tube type with pendant superheater, integral economizer, and a steel-encased, completely water-cooled furnace. To maintain clean heating surfaces necessary for maximum efficiency, a fully automatic Diamond sequential soot blowing system was provided. Steam at 400 p.s.i. is used in retractable blowers in the hotter zones of the boiler while air puff blowers are used in the cooler zones. Compressed air at 275 p.s.i. for the air puff blowers is supplied by a two-stage Ingersoll-Rand air compressor, V-belt driven by a 125-hp. motor.

Forced and induced draft fans were supplied by American Blower. The forced draft fan is driven at constant speed by an induction motor while the induced draft fan is driven at variable speed from a synchronous motor through a hydraulic coupling.

All essential instruments and remote manual controls for all major adjustments are grouped on a central control panel adjacent to the boiler at the liquor burner level. Foxboro instruments and controls are used on the liquor system. Bailey controls and instruments are used for air, steam, and feedwater.

The molten sodium carbonate pours into the smelt dissolv-

ing tank from the furnace and is dissolved in weak wash liquor from the Dorr system. The resulting solution is pumped to green liquor storage in the causticizing plant.

Causticizing

The new causticizing equipment is an open air operation. Only the control panel and test room, and the lime weighing mechanism are enclosed; all other tanks, pumps, and piping are out-of-doors.

Green liquor from the recovery boiler is metered and heated and fed into the Dorr slaker and classifier by a Foxboro flow controller. Lime, which has been unloaded to storage by a Fuller Airveyor system, is continuously fed to the Dorr slaker by a merrick Feedoweight. (A Merrick Weightometer delivers lime to the milk of lime mixing chest for bleach plant use from the same storage tank.)

The liquor from the slaker flows to three Dorr causticizing tanks; complete flow through these takes up to $1^1/_2$ hr. Then, pumped to the Dorr white liquor clarifier, the caustic is separated from the lime mud and put into the Chicago Bridge & Iron 85,000-gal. white liquor storage tank. The lime mud goes to the mud washer where any remaining caustic is recovered and stored as weak liquor. The mud goes to a storage tank and then to a 6-ft. diameter by 6-ft. face Oliver filter on the brown stock washing floor for final washing.

Control of the causticizing operation is centered in a control room-testing laboratory located between the Dorr slaker and the white liquor clarifier. All motors and pumps, weighing and metering operations can be operated and monitored at this point.

Foxboro instruments are used to control the flow of green liquor and the flow of wash water. The temperature of the green liquor is regulated by a Foxboro temperature controller. Temperatures and levels in the slaker and all storage tanks are monitored by control room instruments.

Automatic overflow alarms are to be installed in all storage tanks. The rakes in the white liquor clarifier are equipped with torque overload alarms and indicators to warn the operator of dangerous loading.

The capacity of the causticizing plant is about 100 tons of caustic per day. Part of this is used for cooking and part for miscellaneous operations in the paper mill.

Added Power Capacity

To satisfy the increased electric power requirements of the new pulp mill, a 7500-kw. General Electric mixed pressure extraction condensing turbine was installed. The turbine is direct connected to a 9375-kva., 3-phase 60-cycle, 13,800-v., 3600-r.p.m. generator with direct-connected exciter. The turbine exhausts to a 6500-sq. ft. Ross two-pass divided water box surface condenser.

Because steam output at 875 p.s.i. from the recovery boiler depends entirely on the black liquor supply and all supplementary steam generation in coal-fired boilers is at 400 p.s.i., the turbine was designed to operate as a mixed pressure unit with initial pressure control on the 875 p.s.i. steam. All available high-pressure steam is utilized first, then supplementary 400 p.s.i. steam is admitted through separate control valves to meet load requirements. An extraction connection at 30 p.s.i. is also provided to supply low-pressure steam to the new evaporator and to other low-pressure process services.

When a new coal-fired boiler now under construction goes into service to supply additional 875 p.s.i. steam, the new turbine will be operated without any change as a double automatic extraction unit supplying 400 p.s.i. steam to older low-pressure turbines and 30 p.s.i. steam to process.

The G.E. 7500-kw., 0.8 power factor turbo-generator set generates power at 13.800 v. for transmission to the new pulp mill. Power is delivered to the 13,800-v. bus through a G.E. 1200-amp., 500,000 IC air circuit breaker and then to the new pulp mill through similar G.E. breakers to three G.E. 1500-kva., 13,800–550-v. substations. The first substation serves the recovery boiler, evaporators, and screen room. The second serves the wood yard chippers, barking drums, and conveyors to storage. The third substation serves the digester house, brown stock washer, and causticizing plant. Each operation is served from the substation through G.E. 600-v. switchgear by G.E. cabinetrol motor control centers. Each substation and each motor control center is separately enclosed and forced ventilated with filtered air. Total connected horsepower on the three substations is approximately 5130.

The remaining capacity of the generator is utilized by connection to the existing 4160 and 550-v. generation and distribution systems through three bus tie transformers. The 4160-v. bus tie is a G.E. 7500/9375-kva., 13,800–4160-v. transformer. The two 550-v. bus tie transformers are served by a 2000-ft. tie line connecting to G.E. switchgear located in the older portion of the mill. The two transformers connect to separate sections of a 550-v. split bus; one being a G.E. 3000/3750-kva. transformer and the other a 3750/4687-kva. transformer.

All transformers are Pyranol-filled and fan cooled, and all switchgear is totally metal enclosed, dead front.

Because of the heavy instrumentation and automatic control of the new pulp mill, increased air compression equipment was required. Two Ingersoll-Rand 9 by 9 air compressors were installed. One serves instrumentation and controls in the digester, washer, causticizing, and screen departments while the second compressor supplies instrument and control air for the evaporator and recovery unit. The compressors are rated 153 c.f.m. at 100 p.s.i. Lectrodryers by Pittsburgh Lectrodryer Co. are used to remove all moisture and oil from the air to insure better instrument operation.

Start-up of the new mill was expedited by Pulp Mill Superintendent Clarence Garrett and his assistants and tour foreman George H. Sheets, assistant to division manager O. B. Mason, P. E. Fuller, project engineer, and Booker Bunch, process control supervisor in the division technical service department.

U. of Maine

The University of Maine's forestry department observed its golden anniversary during the first week of October with special ceremonies at Orono. The occasion also marked the fortieth anniversary of the university's pulp and paper courses.

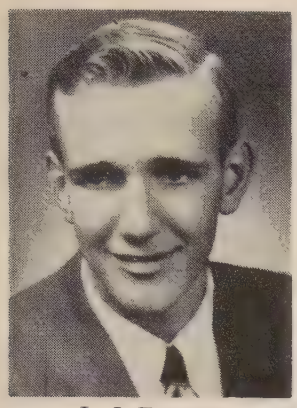
Four men long prominent in the pulp and paper industry and Secretary of Interior Douglas McKay received honorary degrees from the university during the convocation. Those receiving degrees were: Hugh J. Chisholm, president of the Oxford Paper Co.; Dwight B. Demeritt, manager of woodlands, Dead River Co.; Louis J. Freedman, manager of woodlands, Penobscot Chemical Fibre Co.; and J. L. Ober, vice-president Scott Paper Co.

Mr. Ober and Mr. Chisholm, along with Secretary McKay received doctor of laws degrees while Mr. Demeritt and Mr. Freedman received degrees of doctor of science. Recipients of the honorary degrees were presented by Raymond W. Davis, president of the university's board of trustees and the citations were read by Arthur A. Hauck, president.

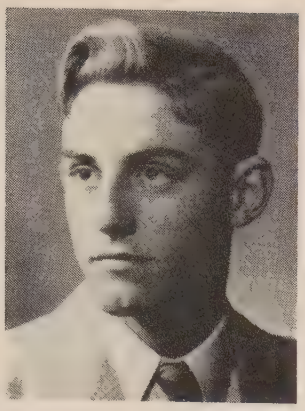
Western Michigan

Eight paper technology students at Western Michigan College, Kalamazoo, Mich., will split some $1800 in scholarship and award money, according to Alfred H. Nadelman, curriculum director.

Leonard J. Timmer, Kalamazoo, is the recipient of two of the awards, having renewed for the third time a scholarship of the Paper and Twine Association, and also receiving this year the award of the Michigan Div., American Pulp and Paper Mill Superintendents Association, for junior students.



L. J. Timmer



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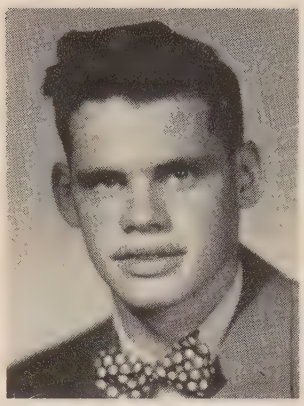
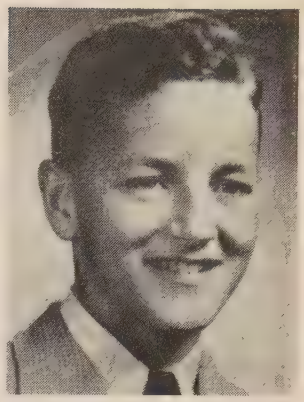


C. E. Elliott



J. Van Giessen

Recipients of Western Michigan College Scholarships

Two other Paper and Twine Association scholarships go to Donald G. Pryor, Kalamazoo, and Thomas R. Murwin, son of Mr. and Mrs. R. L. Murwin, 1601 17th Ave., Menominee, Mich.

The Paper and Twine Association award for salesmanship goes this year to David F. Forsman, son of Mrs. Hilma Forsman, Rhinelander, Wis., while Jake Van Giessen, Kalamazoo, receives the association's award for the top scholastic standing among the sophomores in the curriculum.

Charles W. Ackerman, son of Mr. and Mrs. Bernard Ackerman, 126 East Highway, Vicksburg, has been named winner of the Norman Bardeen scholarship for the year. The William Slavin-Hawthorne Paper Co. scholarship goes to Richard R. Teugh, Kalamazoo.

Recipient of the senior student award of the Kalamazoo Valley Section, Technical Association of the Pulp and Paper Industry, will be Charles E. Elliott, son of Mr. and Mrs. C. Edgar Elliott, 180 Peets Cove, Battle Creek, Mich.

After 5 years as the paper technology curriculum of the chemistry department, a change will be made January 1 at Western Michigan College with the creation of the paper technology department, according to Dr. Paul V. Sangren WMC president.

Alfred H. Nadelman, curriculum director almost since its inception in 1948, will become head of the new department on that same date. This Fall the curriculum boasts 63 full-time paper students, all male, studying under three instructors.

Southern Waste Conference

The Third Southern Municipal and Industrial Waste Conference will take place at North Carolina State College March 18 and 19, 1954. The Conference will feature a symposium on: (1) legal aspects of stream pollution; (2) research (municipal, industrial, and educational) activities and also separate technical sessions for various types of wastes. Nelson L. Nemerow of State College will serve as chairman.

Proceedings of the Second Conference are now available and may be purchased (price $1.00) from the Dept. of Sanitary Engineering, University of North Carolina, Chapel Hill, N. C.

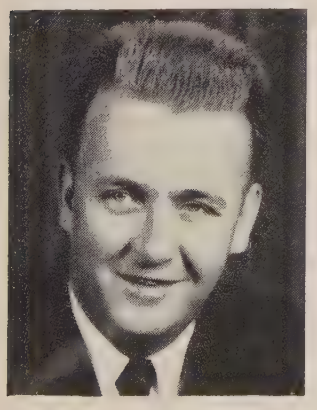
B.D.S.A.

Secretary of Commerce, Sinclair Weeks, has announced the establishment of the Business and Defense Services Administration, a primary organization unit in the Dept. of Commerce.

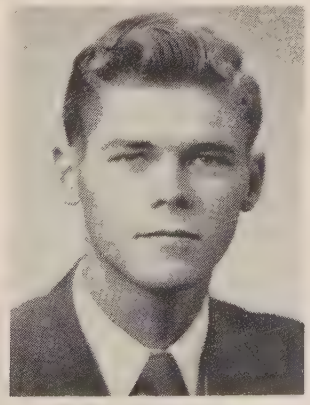
The new agency: (a) continues the residual defense and mobilization functions of the former National Production Authority, as authorized by law, (b) consolidates five current departmental offices, (c) establishes 25 industry divisions, staffed by business experts from government and private industry and (d) provides a focal point for effective cooperation between government and business in promoting economic stability and growth.

The offices transferred to the B.D.S.A. are: the Office of Technical Services, the Office of Distribution, the Field Service, staff functions of the Industry Evaluation Board, and the Office of Industry and Commerce, including its Trade Association, Commodities Standards, and Area Development Divs.

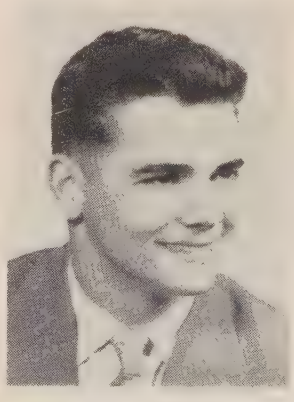
John D. Davis, assistant to the operating vice-president of the Mead Corp., Chillicothe, Ohio, has been appointed director of the Forest Products Div., Business and Defense Services Administration, the Dept. of Commerce announced. Mr. Davis is on loan to the government from his company under the rotation system wherein men from the industry serve the government in the Defense Mobilization Program, and has served as assistant director for pulp, paper, and paper-



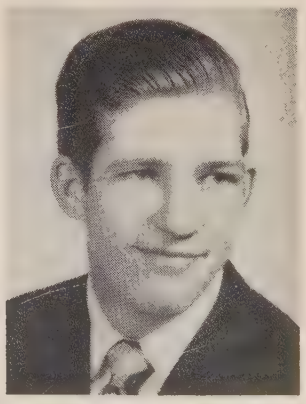
D. F. Forsman



T. R. Murwin



C. W. Ackerman



D. G. Pryor

Recipients of Western Michigan College Scholarships

board for the past 2 months. He holds a degree in chemical engineering from Purdue University, going directly to the Mead Corp. on graduation. He has held various responsible management and technical posts with the corporation before advancing to his present position.

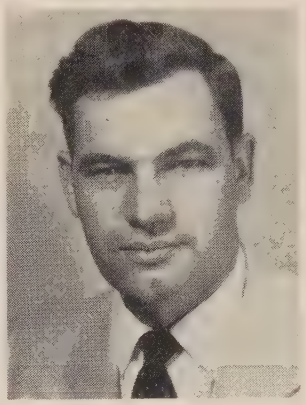
Mr. Davis succeeds Leonard Pasek of Kimberly-Clark Corp., Neenah, Wis., who was recently appointed an assistant administrator of the National Production Authority.

U. of Alabama

The University of Alabama's department of pulp and paper technology, first to be established in the Southeast, is being revitalized, thanks chiefly to an annual grant of $35,000 by the Gulf States Paper Corp. in Tuscaloosa.

The university is the only school in the state, and one of two in the Southeast, that offers such a course of study.

James E. Ayer, former engineer with the West Virginia Pulp and Paper Co., in Charleston, has taken over as acting head of the department. And the money given by the Gulf States firm will help build a modern, complete laboratory to actually manufacture and test paper.



J. W. Ayer, University of Alabama

The South is more and more becoming conscious of the potentialities of the industry, Ayer points out. Authorities expect the papermaking capacity of the Southeast to double in 8 years. Already, Alabama mills alone have a capacity of more than 2000 tons of paper a day.

"This increase means that more and more qualified technicians will be needed in the paper and pulp field," Ayer says.

Eight students have begun basic chemistry courses leading to specialization. They'll begin actual classes in pulp and paper technology next year.

Plant Maintenance Show

Maintenance problems in paper mills and paper product plants will again get special attention at the next Plant Maintenance and Engineering Show which will be held in Chicago, January 25–28, it was announced by Clapp & Poliak, Inc., producers of the show and the Plant Maintenance and Engineering Conference which will run at the same time.

Hundreds of new products, especially useful in the maintenance of paper mills and paper product plants, will be on display in the booths. The exposition will take place at the International Amphitheatre while the conference will be held at the Hotel Conrad Hilton. Two round-table conference sessions have been set aside for exclusive consideration of paper problems.

S. C. Timber Festival

Citizens of Georgetown, S. C., paused this year to pay tribute to an industry that virtually kept the town from dying—the timber and paper industry.

The tribute was in the form of a 4-day Timber Festival, running from Sept. 2 through Sept. 5. Sponsored by the Georgetown County Chamber of Commerce, the festival was financed by the town's merchants.

Behind the festival is a story that goes back 20 years, to 1933 when one of the largest lumber companies in the business closed its Georgetown plant, leaving about 2000 people unemployed. The operation was closed because the company felt it had used up the available timber in that area.

Today, Georgetown, with a population of 6112, is the home of the world's largest kraft paper mill, a plant of the International Paper Co. This plant, which employs upward of 2500 workers, is the town's principal source of income.

In addition, Georgetown County leads South Carolina, and is third in the South among counties in production of pulpwood. Other industries in the county include sawmills and a plant of the General Plywood Corp. And much of its pulpwood also goes to the West Virginia Pulp and Paper Co. plant in Charleston.

The revival of Georgetown began in the late thirties when the International Paper Co. moved in. Extensive forestry practices on the so-called "depleted" lands made them valuable producers of commercial pulpwood and sawtimber crops.

Today, the Chamber of Commerce estimates the income from industry payrolls and timber sales in the county amounts to more than two million dollars a month.

Wisconsin Stream Pollution

Basic differences of opinion between industry and the advocates of drastic stream clean-up were aired at the public hearing in Marinette Wis., by the State Committee on Water Pollution to review stream conditions in Northeastern Wisconsin's three principal swift-water rivers, the Menominee, Peshtigo, and Oconto. State technical men testified that a major cause of pollution in all three rivers is spent sulphite liquor from four pulp and paper mills.

Executives of Kimberly-Clark Corp. and Marinette Paper Co. agreed with state survey figures showing their mills discharge substantial quantities of spent liquor into the Menominee River. They took direct issue with state conclusions that this sulphite liquor harms the stream.

"Sugar in sulphite liquor from our Niagara mill creates good food for fish in the stream," Henry A. Rothchild, Kimberly-Clark assistant vice-president and top expert on sulphite pollution, testified. "This is because the river gets well aerated passing through Sand Portage Falls less than 2 miles downstream. There are more fish below the mill than above it. Building a spent sulphite liquor processing plant at Niagara to keep wood sugars out of the water would do the river more harm than good."

Rothchild pounced on state survey conclusions that pointed a finger at the Niagara mill for low levels of dissolved oxygen in the Menominee in July, 1948. "The only fish kill recorded on the Menominee River below Niagara in three decades was one July Sunday in 1948 when the Niagara sulphite mill had been closed down for almost 24 hours," he asserted. "Those fish died because low water and hot weather caused fermentation in sludge beds of wood chips, sawdust, and bark that have lain on the river bottom since the logging and sawmill operations of the 1880's. That sludge can endanger fish in the future, no matter whether or not spent sulphite liquor is going into the stream at Niagara."

Evidence introduced by Roderick H. Sears, mill manager of Marinette Paper Co., ran along similar lines indicating that under the right circumstances sulphite liquor may be good for fishing. Two dams aerate Menominee River water at the Marinette mill, he pointed out to the committee, and just below the mill is the town's favorite fishing spot.

"Dissolved oxygen in the river water has been consistently above 5 parts per million, the accepted minimum level for fish propagation," Sears testified. "On one occasion in 1949 it dropped to 4.8 parts, which is still good." Listing various steps his company has taken to eliminate sanitary and solids pollution from the mill since 1950 and to use sulphite liquor for roadbinder, he concluded, "It is apparent that these steps which we have taken to prevent river pollution have been effective."

Gilbert K. Dickerman of Wisconsin Rapids, testifying as an expert for the Sulphite Pulp Manufacturers' Research League, used visual education techniques in his evidence before a public hearing on stream conditions in the Oconto, Peshtigo,

and Menominee rivers. With maps, graphs, tables, photographs, and printed exhibits projected on a screen, he outlined how Wisconsin and Michigan sulphite mills are organized to study the subject, how they raise their money and exactly what they spend it for. His pictures exhibited the League's research projects being worked on in laboratories, pilot plants, and proving grounds and showed member mills making full-scale tests in commercial installations of the processes that League scientists had developed.

"To be successful," Dickerman testified, "a process for handling sulphite pollution must prevent the liquor from lowering the dissolved oxygen in the stream below an acceptable level throughout the year and it must avoid all harmful effects. Finally, the net cost to construct and operate it must be low enough to permit the mill to remain competitive."

Starting from this basic need, Dickerman outlined the economic scrutiny that a new process must pass at the hands of League and industry economists after it proves technically sound, before mills can safely adopt this method to clean up the streams. "Wisconsin and Michigan sulphite mills are not insisting that a process must yield a return on the investment," he assured the committee. "But they dare not adopt a method that could prove financially disastrous if its performance should fail to measure up to expectations. Every known method for substantial year-round pollution reduction still falls far short of being a sure thing."

He disclosed facts and figures from the as yet unsuccessful experience of his own firm, Consolidated Water Power and Paper Co, in operating at its Interlake mill in Appleton a full-scale evaporator costing almost $1,000,000 that was started up last March to convert sulphite liquor into industrial fuel so that the liquor would not have to go into the Fox River. "Until our Interlake evaporator proves itself," Dickerman declared, "it necessarily remains an experimental unit and any mill adopting the evaporation-and-burning process will be taking a considerable financial risk."

Next the witness showed on the screen half a dozen pages taken from a market analysis of the torula yeast process. Consolidated had retained a Chicago firm of marketing consultants to survey the possibilities of adopting the yeast process, and the consultants made a full report for Consolidated's guidance. The pages shown at the hearing disclosed present and future markets for torula yeast, actual and probable price fluctuations for torula and competing feed supplements, and estimated the operating costs and profit-and-loss prospects for a million dollar yeast plant producing 3000 tons annually. Results forecasted if Consolidated were to build such a plant ranged from earning a small profit if torula prices should go high, down to suffering a big loss if prices should fall sharply.

"I believe that anyone who faced those figures would decide yeast is too dangerous an answer to the problem raised by the committee's order that our Wisconsin Rapids mill reduce its pollution," Dickerman told the committee. "This is precisely what we deduced.

"No sulphite mill can attain complete pollution abatement and remain competitive until a good deal more is found out than science as yet knows about how to do it," the witness summarized the situation. "But the League and its member mills appear to be getting close to some final solutions," was his encouraging conclusion.

Walter F. Adrian, executive vice-president of Badger Paper Mills, Peshtigo, testified that when a roadbinder program proved too slow in cutting his mill's pollution, the company bought 164 acres of land near the river and diked up a pond in the middle of it. "Company trucks for almost 2 years have been hauling spent sulphite liquor and dumping it in this lagoon," Adrian stated. "State tests indicate that no pollution is getting through to the stream. With trucks running all day and night, in recent months the mill has hauled 90,000 gal. a day or 34% of the total pollutional load it produces."

Forrest Brainerd, plant manager of Falls Paper and Power Co., Oconto Falls, did not dispute state survey figures that show the Oconto River overloaded with sulphite liquor below his mill. He testified that the company's roadbinder program has removed more than 20% of the sulphite pollution during the five warm weather months, and expressed confidence that the mill can boost this to 30% next year.

"We are making an engineering study of the evaporation and burning process," he told the committee. "We are not insisting that before we go ahead, a process must promise us an adequate investment return on the cost of the installation. But we know this is a very small mill with high production costs, and we therefore must not adopt any method that could prove financially disastrous. This mill has gone through several changes of ownership. It is the largest industry in Oconto County and one of the few that gives year-round employment. When it was shut down for several years the community was in great financial distress.

"If we should guess wrong and adopt a process that raised the mill's costs above competitive levels, this mistake would probably put the mill out of business. That is the economic problem that faces a small marginal mill, and there is no way to talk that problem out of existence.

"We stand ready to take further steps to reduce pollution just as rapidly as technical progress makes those steps economically supportable," he assured the committee.

Atlas

The Atlas Mineral Products Co., Mertztown, Pa., has published a booklet on materials of construction which have proved satisfactory for chlorine dioxide production and bleaching processes.

B. & O.

The Baltimore & Ohio Railroad Co. has published an illustrated booklet explaining why trains have the right of way at grade crossings. This booklet is being distributed to driver education teachers in approximately 3500 secondary schools.

Diamond Alkali

Frank Grilli has joined the New York branch sales office of the Diamond Alkali Co.

American Cyanamid

R. C. Ruffer, manager of American Cyanamid's plant at Valdosta, Ga., has announced that construction has begun on a new office-laboratory building, part of a general modernization and expansion program.

Rohm & Haas

The Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa., has announced that F. Otto Haas has been elected executive vice-president of the company. Mr. Haas graduated from Amherst College in 1936, and received a Ph.D. in organic chemistry from Princeton University in 1939.

Foxboro

The Foxboro Co., Foxboro, Mass., has issued a new series of technical information sheets explaining how to determine the level, weight, displacement, composition, thickness, moisture, and other previously unmeasurable characteristics of difficult fluids and solids.

A new bulletin designated as No. 470 describes Foxboro Model 59 valve-mounted controller for high-speed flow control applications.

Armstrong

The Armstrong Machine Works, Three Rivers, Mich., has published a bulletin (No. 268) describing an automatic system

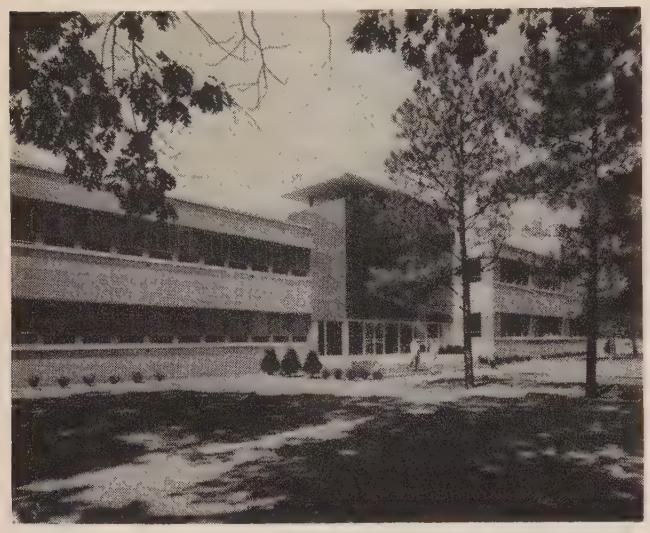
for controlling moisture in board or fine paper as it leaves the drier rolls.

JOHNSON

The Johnson Corp., Three Rivers, Mich., announces a new series 2000 type J Johnson joint, designed for admitting steam or fluids into the rotating rolls and cylinders of paper, textile, rubber, and similar machines.

ALLIED CHEMICAL & DYE

The Nitrogen Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y., has published a bulletin (Pd-B-1) describing Biuret, a new experimental product now available in test quantities.



The new organic research laboratory and development center of the Nitrogen Div., Allied Chemical & Dye Corp. at Hopewell, Va.

Hugo Riemer, President of Nitrogen Div., Allied Chemical & Dye Corp., has announced the opening of an organic development center at Hopewell, Va. The center consists of 2 buildings which provide nearly 40,000 sq. ft. of working space.

SWIFT

L. E. Grieve has been appointed manager of a new Swift & Co. Adhesive Products Dept. recently opened in Dallas, Tex., according to E. R. Paul, manager of Swift's General Adhesive Products Dept. in Chicago. Swift now operates 18 adhesive plants and 4 bone blue manufacturing units in the United States and Canada.

ALBANY

The Albany Felt Co., Albany, N. Y., announces a new 35-mm. color film strip with sound, describing the complete sequence of operations from raw wool to finished felt.

RELIANCE

Reliance Electrical & Engineering Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio, announces expansion of its engineering and technical service facilities on the West Coast to include a direct factory sales office in San Francisco, and additions to its engineering personnel in both San Francisco and Los Angeles. A new West Coast personnel will include Walter A. Jensen in San Francisco and Perry Dudley, Jr. in Los Angeles. Peter W. West formerly at the company's Cleveland headquarters will join the Buffalo staff.

Also announced is the promotion of Paul W. Arnold to the position of manager of marketing services, and Charles R. Sutherland to the position of chief engineer. James D. Weber has been appointed sales application engineer in the Detroit district sales office.

DOW CORNING

Dow Corning Corp., Midland, Mich., has published preliminary data sheets describing Dow Corning XC-271, a new silicone adhesive.

GENERAL DYESTUFF

The Antara Chemicals Div. of General Dyestuff Corp., 435 Hudson St., New York, N. Y., has published a new booklet presenting basic products information on its line of Igepons, synthetic surfactants formed by chemical reaction of a fatty acid with an organic sulphonate.

DU PONT

The Electrochemicals Dept. of the E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del., has published a technical booklet (Peroxide Products Bulletin P55-953) which describes a new method for pretreated groundwood with calcium chloride before peroxide bleaching.

The manufacture and sale of lithopone pigments will be discontinued by the Du Pont Co., as of the end of next February.

ROANWELL

The Roanwell Corp., 662 Pacific St., Brooklyn, N. Y., has issued a booklet (SE-1) describing the Aerosensor, a highly sensitive automatic instrument for the continual detection and measurement of micro variations in thickness or other measurements, through air gaging.

DELAWARE VALLEY

The Delaware Valley Engineering Co., 3326 Lancaster Ave., Philadelphia 6, Pa., has published a bulletin (SP-CV-1) presenting specifications for diaphragm control valves.

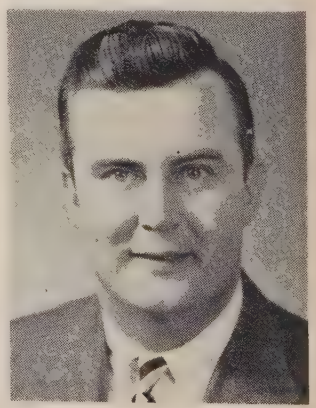
GIVAUDAN-DELAWANNA

R. E. Horsey, vice-president in charge of sales of Givaudan-Delawanna, Inc., 330 W. 42nd St., New York, N. Y., and its associate companies Givaudan-Flavors, Inc., and Sindar Corp., has announced that James L. Stevenson has joined his father, Ralph M. Stevenson, in the representation of the Givaudan organization in the Detroit area.

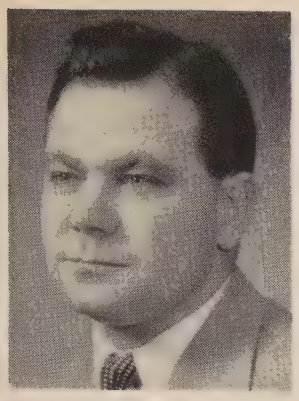
STALEY

The Staley Manufacturing Co., Decatur 60, Ill., announces the following appointments: Ray E. Kilty has been made assistant manager of the Boston sales office. Richard C. Dempsey is appointed technical sales representative to work

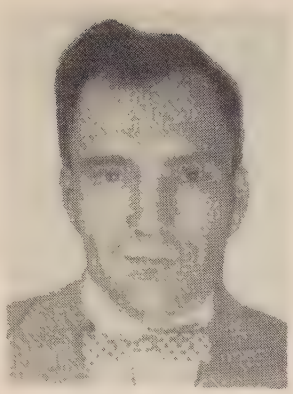
R. E. Kilty, A. E. Staley Mfg. Co.



R. C. Dempsey, A. E. Staley Mfg. Co.



J. W. Rose, A. E. Staley Mfg. Co.



C. H. Guischard, J. O. Ross Eng. Corp.

with the paper industry in the New England States. Crawford H. Garren becomes sales representative to work with the textile industry, and Jack W. Rose will represent the company in the Chicago sales office to work with the corrugating industry.

The Staley Co.'s 1952 annual report has been judged best in the United States milling industry in the annual competition sponsored by *Financial World* magazine.

Ross

The J. O. Ross Engineering Corp, has appointed Charles H. Guischard to handle engineering and sales of pulp and paper mill equipment in its Pennsylvania territory.

Minneapolis-Honeywell

Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia, Pa., has published the following instrumentation data sheets: No. 9.6-7 describing controlled water treatment; No. 10.10-4 describing the Gardner automatic photometric unit; 29.0-5 describing the DeZurik consistency regulator used with a Brown recording pneumatic controller; No. 29.6-2 describing automatic control of a Shartle Bros. Duo-cycling system. Bulletin 6504 describes industrial hair hygrometers, thermometers, recorders, and recording controllers.

F. C. Huyck

F. C. Huyck & Son has published a brochure describing Dewpruf, a new treatment for the prevention of bacteria damage.

The Huyck Co. now has the following engineering staff in the field: George H. Gill III, Warren C. Naugler, William E. French, and John C. Spicer. Before receiving field assignments Huyck engineers undergo at least a 2-year four-phase training program, including extensive experience in felt manufacturing methods and procedure, actual work in all types of paper mills, a period of apprenticeship in Huyck's felt design department, and field training in diversified problems. A number of trainees are now engaged in various phases of this program.

Merritt-Chapman & Scott

The Merritt-Chapman & Scott Corp., 260 Madison Ave., New York, N. Y., has issued a brochure illustrating the wide diversification of work ashore and afloat performed by this construction company.

A-C

The Allis-Chalmers Mfg. Co., Milwaukee 1, Wis., has released a new bulletin (07B8040) describing a new air-cooled kiln end.

Dwight H. Lory, formerly assistant to the general manager of the A-C Norwood plants, has been named assistant manager of the Texrope drive section located at the company's plant No. 2 in Cincinnati.

Philadelphia Quartz

The Philadelphia Quartz Co., Philadelphia 6, Pa., announced the addition of two new products to its line of soluble silicates—hydrous sodium metasilicate and sodium orthosilicate, known as Metso and Hydrous and Metso 200.

Stickle

The Stickle Steam Specialties Co., Indianapolis, Ind., has developed a system for the automatic control of moisture content in paper and board, known as the Automatic Tension and Pressure Trol.

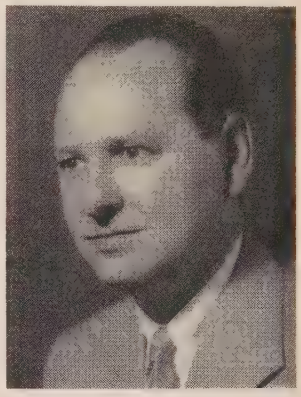
National

National Adhesives Div. of National Starch Products Inc., 270 Madison Ave., New York, N. Y., announces the appointment of R. M. L. Francis, to the position of president of the newly formed Adhesives Manufacturers Association of England.

National Starch Products, Inc. has developed a new series of chemically treated starches, known as Napon, that have unusual emulsifying properties.

Olin

Olin Industries, Inc., East Alton, Ill., announces the appointment of Frank A. Peschl to the position of director of engineering. Mr. Peschl was in charge of engineering for the Ecusta Paper Corp., subsidiary of Olin Industries, at Pisgah Forest, N. C.



L. Gussman, Stein, Hall & Co.

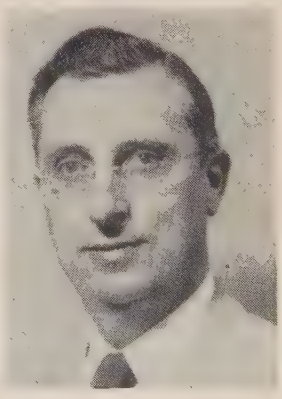
Stein, Hall

Edwin Stein, chairman of the board of Stein, Hall & Co., Inc., 285 Madison Ave., New York, N. Y., announces with deep regret the resignation of Morris S. Rosenthal as president and director, and as a director of Stein, Hall's affiliated companies. Lawrence Gussman has been elected new president of Stein, Hall.

Witco

Melville C. Vaughan has been promoted from the position of salesman to sales manager of the Cleveland, Ohio, office of the Witco Chemical Co., 260 Madison Ave., New York, N. Y.

M. C. Vaughan, Witco Chemical Co.



M. S. Vaccarro, Witco Chemical Co.

Michael D. Vaccarro has been promoted to eastern sales manager. Mr. Vaccarro has been active in the Witco sales force in Pennsylvania, New Jersey, and New York.

G.E.

The General Electric Co., Schenectady 5, N. Y., has published a bulletin (GEA-5947) describing photoelectric side register control systems.

Bulletin GEA-5965 contains information on a complete line of G.E. time switches, processers, timers, and time meters. A new line of polyphase A.C. motors has been announced by G.E.'s Small Integral and Medium Induction Motor Developments. The new line, called Tri-Clad 55, is described in three booklets as follows: GEA-6013 covers drip-proof motors; enclosed motors are presented in GEA-6012; GEA-6027 describes the new gear motors.

H. S. Farmilo has been named manager of the Philadelphia sales district of G.E.'s Distribution Assemblies Dept.

G.E.'s Special Products Section announces the development of a general-purpose metal detector which can be installed around conveyor systems without cutting the belt.

Ingersoll-Rand

Ingersoll-Rand Co., 11 Broadway, New York, N. Y., announces a new size 2U Electric Impactool for use on nut running, tapping, screw driving, reaming, drilling, etc.

Pipe Fabrication Institute

The Pipe Fabrication Institute, 813 Clark Bldg., Pittsburgh 22, Pa., has issued a technical bulletin TBI-1953 containing pressure temperature ratings on grades of pipe common in power plants.

Westinghouse

Robert H. Wagner has been appointed general application engineering manager of the Westinghouse Elevator Div. in Jersey City, N. J.

A 16-page bulletin (B6093) describes the equipment available for use in the electronics industry. This is available from the Westinghouse Electric Corp., Box 2099, Pittsburgh, Pa.

Present at a dinner during the visit of C. W. Converse of the Sprout, Waldron & Co., Secretary, TAPPI Semichemical Pulping Committee to Japan were: T. Oma, Jujo Paper Mfg. Co.; S. Kashio, C. T. Takahashi & Co.; T. Kasahara, C. T. Takahashi & Co.; S. Idogawa, Tohoku Pulp Co.; S. Inouye, Odawara Paper Mfg. Co.; K. Nagai, Secretary-General, Japanese TAPPI; N. Kondo, Jujo Paper Mfg. Co.; Y. Seki, Mitsubishi Paper Mfg. Co.; S. Yamanouchi, Honshu Paper Mfg. Co., Director-General, Japanese TAPPI; M. Kinoshita, Oji Paper Mfg. Co.; M. Takahashi, Jujo Paper Co.; and Y. Ichikawa, Honshu Paper Mfg. Co.

Dow

The Dow Chemical Co.'s new plant for the manufacture of Styron (Dow polystyrene) plastic has started production at Torrance, Calif.

Hercules

A new technical bulletin about the use of ethylcellulose in specialty coatings is now available from Hercules Powder Co., Wilmington, Del.

American Resinous Chemicals

American Resinous Chemicals Corp., Peabody, Mass., announces two new resin emulsion tackifiers—Arccos 25 and 26 which are described in data sheet A-45.

B-C

The name of B-C International Ltd., has been changed to Black-Clawson International Ltd. The firm is now located at Black-Clawson House, 23-A Maddox St., London, W.1, England.

International Nickel

The International Nickel Co., 67 Wall St., New York 7, N. Y., has published a bulletin in two parts (A-107-8) describing Ni-Vee bronzes, a series of low-shrinkage, heat-treatability bronzes for machine component pressure and bearing castings. Bulletin A-49 gives data on the corrosion-resisting properties of austenitic chromium nickel stainless steels.

Carpenter

The Carpenter Steel Co., Alloy Tube Div., Union, N. J., announces that the October 20 removal of the last BDSA alloy controls now releases nickel bearing Carpenter stainless No. 20 to general industry without restriction. Stainless No. 20 is a sulphuric acid-resisting stainless steel.

Link-Belt

The Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., has announced the appointment of Huvey V. Eastling as general manager of the company's Pacific Div. with headquarters in San Francisco. He succeeds Ralph M. Hoffman who has retired after 40 years of service.

Nopco

Thomas A. Printon, president of Nopco Chemical Co., Harrison, N. J., has announced the purchase of the controlling interest of Yocum Faust Ltd. of London, Ont., Canada. The subsidiary company will continue to operate under its original name.

Allis Motor

Louis Allis Co., Milwaukee, Wis., has announced a completely redesigned, restyled line of electronic motors for industry, representing a basic change in frame size. The change, company officials said, means "the same horsepower in smaller packages." In some cases the output will actually be doubled for the size of the motor. The new series covers the 1 to 40-hp. range, and is in line with the new frame standards set by the National Electrical Manufacturers Association in November, 1952, to become effective in January, 1954.

Egan

William H. Willert, sales engineer for the Frank W. Egan Co., Bound Brook, N. J., has just returned from Italy where he supervised the installation of the first polyethylene coating machine set up in Italy. The machine was installed near Venice for Cartiere-Burgo, the largest group of paper mills in Italy. The company manufactures newsprint, kraft, and other grades of paper including coated stock.

Foster Wheeler

Foster Wheeler Corp., manufacturers of heavy equipment for steam power plants, oil refineries, and process industries has begun limited operations at a new plant in Mountaintop, Pa., 9 miles south of Wilkes-Barre.

Equipped with the most modern fabricating tools, the $5 million plant will turn out pressure vessels of varying proportions, including some of the largest and heaviest in demand. Part of an $8 million expansion and retooling program begun 3 years ago, the new plant will also help to relieve heavy manufacturing schedules at the corporation's other plants in Carteret, N. J., Dansville, N. Y., and St. Catharines, Ont.

Among its major tools will be an 8000-ton hydraulic beam press weighing over 3 million lb. and said to have an effectiveness in bending steel plate—hot or cold—seldom before equaled. Largest of its type yet made, the press is capable of bending plate 8 in. thick, and (in the case of lighter plate) 40 ft. long into half-shells which, when welded together, will form pressure vessels of the unusual proportions required for the higher pressures demanded by various industries. It was built by Baldwin-Lima-Hamilton of Philadelphia, Pa.

The press is hydraulically operated, using the simplest type of circuit, which is aided by valves and pressure gages, to protect the system against overloading. Control of the speed of the moving beam is at the discretion of one operator. Such control is accomplished by means of a single lever, the position of which determines the speed and direction of motion: up or down. The press is designed to provide daylight of 96 in. maximum between the lower surface of the upper bending beam and the upper surface of the lower bending beam. Maximum operating speed under no-load conditions, up or down, is 82 in. per min.; maximum pressing speed is 12 in. per min.

To facilitate handling of the hot steel plate, there is also a unique plate handling device which positions the plate to be formed, easily and with minimum loss of metal temperature. Especially designed by Baldwin-Lima-Hamilton, the plate-joggling mechanism will handle plates up to 40 tons each.

Another outstanding tool will be a 2-million-v. Van de Graaff x-ray generator capable of penetrating steel 12 in. thick. The machine will photograph weld metal with unprecedented clarity of detail, exposing any minute flaws that may occur in the metal. Using fewer and shorter exposures, it will perform its work in considerably less time than conventional x-ray equipment. The Foster Wheeler unit will be the first application of supervoltage x-ray in private industry.

To guard against the possibility of escaping rays from the powerful machine, it will be housed in a fortresslike structure, with walls of reinforced concrete 4 ft. thick, and removed 550 ft. from the main plant.

The new automatic shielded welding process was built to specifications by Cecil Peck Co. of Cleveland and Lincoln Electric Co. These automatic welding machines are power driven and rest on bases which can be raised or lowered to accommodate vessels up to 12 ft. in diameter and which travel on a track 150 ft. long. The units are type LAF, automatic flux recovery, power-driven booms which are controlled at the operator's station. These automatic welders are capable of welding plate 8 in. thick at speeds considerably faster than single wire welders.

The plant is equipped with two sets of high-speed radial drills, each with an 8-ft. arm and 19-in. column, mounted and arranged in series—one set of six, with the two end drills fixed, and another of four, with one end drill fixed. Besides, there are several single mounted drills located in a side bay which will be used for lighter work.

The radial drills are mounted along a 230-ft. section of raised track and may be positioned, by power equipment, anywhere along the ways. Drums or other pressure vessels to be drilled will be placed on both sides of the ways and laid on power rolls that permit easy turning of the cylinders.

With this arrangement, any combination, using up to six drills on a single drum, will be practical. This also permits 100% use of the drills at all times, regardless of the number or size of units to be drilled.

The electric system was designed with particular attention to safety, future expansion, pressure drop (such as could be caused by long lines from substation to final user), and to minimize the effect of simultaneous starting by big users.

Power is supplied by two high tension lines, each line carrying 66,000 v. to the substation. Two 2500-kva. transformers step this voltage down to 4160 v. before distributing the power to four power centers within the plant which will require an estimated average daily load of 3500 kva.

Four power centers, close to the huge machines to be fed, rest on elevated platforms between the bays of the main floor, allowing full use of floor space for production work. Here the voltage is again stepped down to 480, and distributed through various columns in the building to the individual machines through underground connections. A safety switch for each machine, or group of machines, is located at the building columns.

These power centers are placed so that there will be a minimum of voltage drop to any machine at all times. Under this arrangement, like users will not be dependent upon one power center, nor will big users have to draw on one, or two, power centers. Welding equipment, for example, is fed from several of the power centers. Cranes and compressors—both being large, constant users—are fed from different power centers. The 8000-ton beam press—while it is a large user—operates intermittently, while the x-ray machine uses relatively little power. The latter is fed from one of the power centers to transformers in the x-ray building.

Lighting at the plant was designed to diffuse an intensity of 30 ft. candles over the entire 89,500 sq. ft. of work area. To accomplish this, approximately 330 sealed beam lamps of 750 w. each (including lights placed under cranes to prevent casting of shadows) are distributed throughout the plant.

Kenneth L. Walker has been appointed superintendent of the new plant of Foster Wheeler Corp. Before being assigned to Mountaintop, Mr. Walker was superintendent of the boiler shop at the Carteret plant of the corporation. He joined the Foster Wheeler organization at this plant during 1934 and specialized in welding and fabrication.

OBITUARY

Hans Zanders Schniewind

Hans Z. (Jack) Schniewind, president of Testing Machines, Inc., New York, N. Y., died at his home in Daytona Beach, Fla., on Oct. 20, 1953.

Mr. Schniewind was born in Whitestone, N. Y., on April 1, 1885, and studied paper testing and technology under Dr. Muller in the paper mills of J. W. Zanders in 1910 and 1911. Mr. Schniewind was a member of the old German papermaking family of Zanders.

As a young man Mr. Schniewind was manager of the New York sales office of the Strathmore Paper Co. Following World War I he engaged in the brokerage of paper obtained from abroad. He also established the American agency for the testing machines made by Louis Schopper of Leipzig, Germany, and changed the name of his firm from Foreign Paper Mills, Inc., to Testing Machines, Inc. Readers of the trade papers over the past quarter of a century may recall the involvement of Mr. Schniewind in the patent litigation relating to the freeness tester.

TAPPI DIVISIONS AND COMMITTEES

Reports of Activities

Mechanical Pulping Committee

The Mechanical Pulping Committee has held three meetings this year, as follows: February 16 in New York, July 15 in Syracuse, and November 4 in New York.

Recognizing the need for readily accessible and up-to-date information on groundwood mill equipment and practice, it chose as its objective for 1953 the publication of a monograph. This will contain data on equipment and methods presently being used in the groundwood mills of the United States, and will cover all aspects of the process from grinder to bleachery.

Questionnaires have been circulated and replies received from over 50% of all groundwood mills in the country. This gratifying response is indicative of the widespread "interest" of the industry in this project. These responses are at present being summarized by the committee in the form of a monograph which is scheduled for publication at an early date.

Membership of the committee is as follows:

F. W. O'Neil, Chairman, State University of New York, College of Forestry, Syracuse 10, N. Y.
J. H. Perry, Secretary, Norton Co., Worcester 6, Mass.
W. H. de Montmorency, The Pulp & Paper Research Institute of Canada, 3420 University St., Montreal, Que., Canada
J. H. White, Keyes Fibre Co., Waterville, Me.
J. K. Kirkpatrick, Champion Paper & Fibre Co., Pasadena, Tex.
Axel Hytinnen, 5712 Old Saud Rd., Madison 5, Wis.
T. F. LaHaise, Imperial Paper & Color Corp., Plattsburg, N. Y.
R. L. Leaf, Jr., Little Rapids Pulp Co., Shawano, Wis.
E. H. Johnson, Stevens & Thompson Paper Co., Greenwich, N. Y.
T. E. Kloss, Hollingsworth & Whitney Co., Waterville, Me.
R. S. Magruder, Sprout, Waldron Co., Inc., Muncy, Pa.
K. L. Pingrey, The Diamond Match Co., Ogdensburg, N. Y.
N. F. Robertson, West Tacoma Newsprint Co., Box 8, Steilacoom, Wash.

Paper Testing Committee

The Paper Testing Committee met at the Battelle Memorial Institute, Columbus, Ohio, Sept. 22 and 23, 1953, for their annual Fall meeting. Those members in attendance were: D. H. Newcomb, chairman, D. M. Black, W. P. Dohne, R. B. Hobbs, S. C. Fairbanks, J. T. Ward, P. F. Wehmer, and R. H. Wiles. In addition there were numerous guests who actively and generously participated in the activities of the meeting.

The chairman announced that as a result of the committee's work on the writing of test methods for "Blood Resistance of Butcher's Wrapping Paper" and "Pinholes in Glassine and Greaseproof Papers" that these methods had been accepted by the Standards Committee and that they appeared in the September, 1953, issue of *Tappi*.

The test methods discussed during the two-day meetings were as follows.

T 411 m-44, Thickness and Density of Paper

Since the February meeting a copy of the Bureau of Standards Circular 532 "Measurement of the Thickness of Capacitor Papers" was sent to each member. Using this as a basis for the discussion it was unanimously agreed that there was a definite need for a standard test method for measuring the thickness of thin papers. This naturally led to a discussion of bulk and bulk testing. Because of the interrelationship of the test methods for determining thickness and bulk it was suggested that the two methods, T411 and T 426, be combined. After considerable discussion it was decided that the committee should do extensive work on the measurement of thickness and bulk but work on them as separate methods. Two subcommittees were appointed to work on these methods: T 411 m-44, Thickness of Paper, P. F. Wehmer, who will start his work by contacting members of ASTM, D6; and T 426 m-46, Bulking Thickness, J. T. Ward, who is to investigate the various bulking testers currently being used and obtain and compare testing methods used for obtaining bulking thickness.

T 433 m-44, Water Resistance of Paper (Dry Indicator Method)

This method was discussed at quite some length, especially in regard to the type of dye, starch, and sugar, the methods of mixing these, and the proper amount that should be used. Mr. Wehmer suggested that a low-powered magnifying glass of about 3× be used to help determine the end point, stating that with such a glass it was very easy to determine the change in color of the dye due to vapor and that due to the transudation of water through the sheet. The former is a gradual change in color whereas the latter is a color change accompanied with the dissolving of the sugar crystals. Much discussion was held relative to the work done on this subject by Mr. Carson. R. B. Hobbs was appointed chairman of a subcommittee to investigate this work and report to the Testing Committee with suggestions for improving the present standard test method. D. M. Black was also appointed to this subcommittee.

T 437 m-43, Dirt in Paper

R. H. Wiles, chairman of the subcommittee working on this method, reported that the investigation conducted by J. T. Ward has indicated the practicability of measuring amount of illumination to be used in foot-candles. As a result of this work and in conjunction with other data at hand, this subcommittee is to correct T 437 m-43, contact the TAPPI Pulp Testing Committee for comments, and submit their recommendations to the full committee. The optimum illumination was found to be 50–55 foot-candles in the above-mentioned investigation.

The Paper Testing Committee which met at the Battelle Memorial Institute, Sept. 22–23, 1953

T 451 m-45, Rigidity, Stiffness, and Softness of Paper

It was felt by the committee members present that T 451 should be studied for possible revision in view of the fact that the method as written does not hold for the heavier weight papers and paperboards. To this end a subcommittee headed by E. F. McCarty was appointed to establish the operating ranges of the present stiffness testers, such as the Clark, Gurley, Taber, and the Carson-Worthington and to contact The Institute of Paper Chemistry relative to the cost of making an instrumentation study on the Carson-Worthington to facilitate obtaining accurate information concerning this instrument.

T 454 m-44, Turpentine Test for Grease Resistance of Paper

As the result of a discussion on grease resistance a subcommittee was appointed consisting of S. C. Fairbanks, chairman, and W. P. Dohne, to rewrite the present method to incorporate the wording this committee used in writing the test method T 485 m-53, "Pinholes in Glassine and Greaseproof Papers" in reference to the backing paper used and in making up the turpentine solution. This subcommittee is also to investigate the possibilities of developing a standard test method for determining the creased grease resistance of papers, both light and heavy weight.

The chairman announced that B. L. Wehmoff and M. S. Kantrowitz were to continue their work as a subcommittee on T 459 m-48, Wax Test for Surface Strength of Paper, and that P. W. Codwise was to continue his work on T 478 sm-50, Erasing Quality of Paper.

As a result of reviewing and discussing it was recommended that the following standard be corrected as noted:

T 409 m-35, Machine Direction of Paper

Add the following sentence to the paragraph headed "Test Specimen," "Flat paper is required for conclusive tests for Method 2."

T 431 m-45, Ink Absorption of Blotting Paper

In the second paragraph under "Procedure" the temperature of the ink should be changed from 21°C. to read 23°C. (73°F).

T 441 m-45, Water Absorptiveness of Nonbibulous Paper and Paperboard

The second sentence in the first paragraph which is, "It is suitable for determining water penetration into paper and paperboard 0.004 in. and over in thickness" be changed to read, "It is suitable for determining water absorptiveness of paper and paperboard 0.004 in. and over in thickness which has been sufficiently sized so that water will not penetrate to the under side of the sheet in less than 60 sec."

T 455 sm-42, Wire and Felt Sides of Paper

This method was discussed and the following points were brought up: (1) The term "felt side" no longer has a justifiable basis and should be changed to "top side." (2) Method no. 4 which describes the determination of the sides of paper by means of drying has been found to be misleading and therefore should be eliminated. (3) The determination of wire or top side of paper by examining the crease produced on a folding tester was thought to be a reliable method and that it should be included in the standard. (4) The determination of the wire or top side of paper by use of the Cobb size test has been found to be very reliable in cases of sized papers, the water absorption always being greater on the wire side. It was also felt this method should be included in the standard. This committee will review this test method again at a later date.

T 445 sm-44, Identification of Specks and Spots in Paper

This method was reviewed and discussed relative to the proper responsible committee, C. E. Brandon, chairman of the Microscopy Committee, being present and stating that his committee had been working on this method. It was generally felt by the members of this committee that as many of the methods used incorporated the use of microscopy that the Microscopy Committee may well be the responsible committee. Regardless of the outcome of this discussion it was decided that a joint Paper Testing and Microscopy Committee meeting should be held. This has been tentatively set for Wednesday morning of the February Annual Meeting in New York City.

It was suggested that the sources of supply of the various materials and instruments used in TAPPI Standards and Suggested Methods should be published in some form. Most members felt that a list of sources should be published for insertion in the Standards binder. Mr. Newcomb is to write to Mr. Clark, Mr. Casey, and Mr. Griffin about this.

D. H. Newcomb, *Chairman*

Papermaking (Fourdrinier) Committee

The meeting of the Papermaking (Fourdrinier) Committee was called to order at 2:15 p.m. Monday, Feb. 16, 1953, by Noel R. Phillips, chairman. The program for the Fourdrinier Committee was announced for the current meeting. This included the following:

1. "The Maintenance of Basis Weight" (closed session).
2. "Paper Machine Efficiency Formula" (closed session).
3. "Drying Problems in the Manufacture of Tissue," Tissue Subcommittee (closed session).
4. Papermaking (Fourdrinier) Session (open meeting).
   (a) "The Deculator on a Kraft Paper Machine," by A. W. Duskin and W. B. Jenkins, Crossett Paper Mills, Crossett, Ark.
   (b) "Automatic Transfer Equipment," by J. E. Goodwillie, Beloit Iron Works, Beloit, Wis.
   (c) "The Liquid Ring Compressor—Some Thermodynamic Characteristics," by Harold E. Adams, Nash Engineering Co., South Norwalk, Conn.

The committee agreed that the sessions held at the last two national conventions had been very beneficial and productive. In accordance with this opinion, many suggestions were offered as subjects for questionnaires during the coming year. Below is a partial list of these topics:

1. The optimum conditions for mixing stock and white water to obtain an even consistency on the wire.
2. The ideal arrangement of the fourdrinier wet-end.
3. The use of suction equipment in fourdrinier operation including the arrangement, design, and operation of flat boxes and suction rolls. The methods for cleaning suction rolls were also suggested as a subject for discussion.
4. The use of perforated rolls to aid in the spread and formation of the sheet on the wire.
5. The removal of air from stock as an aid in fine paper formation.
6. The design, arrangement, and operation of press sections.
7. The types of drier felts and the problems associated with their operation. This discussion would include drier felt seams, felt porosity, drier picks, and the temperatures of driers.
8. Slitter dust and the methods of combating this problem.
9. The measurement of draws between individual driers and between drier sections.
10. The effect of water deflector design in lightweight paper manufacture.
11. Different dandy-type table rolls and their effect on sheet formation.
12. The use of automatic devices for feeding alum, rosin, clay and other additives to paper furnishes in fourdrinier operation.

During the committee meeting Frederick Bishop of Southland Paper Mills, Inc., Lufkin, Tex., presented information concerning a new type of wire patching device which welds

circular patches in the body of the wire with little or no change in the structure of the wire.

It was also suggested that the above subjects might be handled during an informal question and answer period in a committee meeting, as well as being the subjects for questionnaires.

Considerable interest was also shown in the possibility of having a joint Fall meeting on papermaking in conjunction with the Cylinder Committee in a well-known papermaking center of the United States. Such a meeting might be possible for 1954 or 1955.

Listed below will be found reported of the committee's two sessions that were held during the 1953 Annual Meeting. Section I covers a summary of the questionnaire and discussion covering, "The Determination of Paper Machine Efficiency," while Section II reports on the session held on the subject of Basis Weight Control.

Report of Papermaking (Fourdrinier) Committee Discussion on the Determination of Paper Machine Efficiency

Mr. Phillips opened the meeting on paper machine efficiency by summarizing the results of the committee's questionnaire sent to over 40 mills.

In determining paper machine efficiency 55% of the mills divided the actual tonnage produced by the optimum tonnage value. The other 45% utilize the same type of relationship but included the component of quality in determining the efficiency. Twenty-five per cent of the former group indicated that they would like to include a quality factor, but they did not know how to include this property.

The uses for the value of the paper machine efficiency fell into three categories: (1) determination of bonus rates; (2) determination of grade costs; (3) a combination of these purposes.

In ascertaining whether a universal paper machine efficiency formula could be obtained, 55% replied that it could, while 45% did not believe such a formula could be developed. The formulas suggested resolved themselves into one or the other of the following:

$$1.\quad \%\ \text{efficiency} = \frac{\text{salable paper}}{\text{maximum theoretical production}} \times 100.$$

$$2.\quad \%\ \text{efficiency} = \frac{\text{actual production on machine}}{\text{standard grade production}} \times 100.$$

The discussion group demonstrated an interest in the formulas used by several of the group particularly concerning methods of deducting lost time and rejections. Below is one of the formulas developed to take these factors into consideration.

Reel speed × factor = gross theoretical production
Lost time = minutes = production
Rejections = production

$$\frac{}{\text{Production for losses}}$$

Gross theoretical production − production losses = net theoretical production

$$100 \times \frac{\text{actual production}}{\text{net theoretical production}} = \%\ \text{efficiency}$$

Another member of the group mentioned the method utilized by the mill in rating the efficiency of their machine crews for purposes of bonus payments. The following factors were taken into consideration and compared with the average of the last four runs on the same grade:

1. 40% waste.
2. 30% down time.
3. 20% production rate.
4. 10% yield (shrinkage due to stock losses).

These four factors are converted to actual operating time and the bonus paid on the per cent improvement times the base rate of each person involved in machine operation.

Other methods for bonus computations were mentioned based on the improvement in grade profit divided by time on the machine and the decrease in cost per pound of paper for a particular grade. Due to the varied interests in the nature or use of a formula for the efficiency of a paper machine, the group felt that no one unversal formula could be devised at this time.

Report of Papermaking (Fourdrinier) Committee Discussion Meeting on the Maintenance of Basis Weight

To open the discussion of this topic, a summary of the committee's questionnaire on basis weight maintenance was presented by Mr. Phillips. This material was assembled from reports of over 40 mills located in the United States and Canada.

Approximately 82% of the mills maintained the basis weight of their sheets within ±5% of standard weight, while 9% reported that their variation was less than 5%. Nine per cent of the mills operating on book papers followed trade custom with a ±8% variation under a 40-lb. sheet weight and ±8% when manufacturing sheet weights over 100 lb. basis weight. These weights are for sheets made to the 25 × 38—500 basis.

The average per cent basis weight variations reported by mills are as follows:

23% mills ±5% of standard basis weight
10% mills ±4% of standard basis weight
47% mills ±3% of standard basis weight
10% mills ±2% of standard basis weight
2 mills less than ±1% of standard basis weight

In reply to a question concerning the maximum and minimum basis weight variation during one run the following results were reported:

38% of the mills ±3–4% of the standard basis weight
24% of the mills ±4–5% of the standard basis weight
24% of the mills ±7% of the standard basis weight
2 mills ±10% of standard basis weight

Forty of the mills (77%) answering the questionnaire indicated that they were not satisfied with their basis weight control; 7% replied that their control was adequate (not too bad), and 16% said their basis weight control was satisfactory.

In considering the reasons for poor controls of basis weight, 80% mentioned poor consistency control, 20% drive limitations, and 38% blamed their wet-end arrangements.

To further pursue the problem of consistency regulation the majority of the mills responding to the questionnaire mentioned the use of three different makes of regulator. Ninety per cent utilized the regulators on the total flow of stock through the machine system and 10% measured a portion of the total flow for control. Automatic controls were used in conjunction with 60% of these controllers, while the remaining 40% were actuated by manual controls. The placement of the regulators in the machine system was indicated as follows:

26%—between beater and jordan chests
60%—at the stuff box
14%—after stuff box at gate of headbox

In response to the question concerning the effect of open or closed white water systems on basis weight control, 46% said that there was no effect, and 38% indicated that there was a definite effect, while 16% answered that they did not know.

After the report on the Papermaking (Fourdrinier) Committee's questionnaire, the matter of basis weight control was thrown open for group discussion. Many suggestions and problems of the members present were considered and a summary of these follows.

Stock stratification in storage chests after consistency regulation was found by one member. On at least one set of tests the consistency varied between the top and bottom of the

machine chest from 4.5 to 2.5%, even though the chest was thought to have adequate circulation.

Several reasons were given for stock consistency variation with the use of conventional consistency regulators. Changes in the stock characteristics (change in degree of refining) will cause variations in the consistency and therefore the output to the machine will change. A change in filler characteristics will also cause consistency variation due to its influence on the action of most regulators.

The effect of the changing level within a stock chest was mentioned as a cause for variation in pump output and thus a difference in the quantity of stock passing through a stuff gate due to head variations. Many methods have been used to minimize this variation; such as a constant level chest, maintained by the use of automatic controls. During the course of this discussion on stock chests it was pointed out that if consistency regulation was sufficiently accurate there would be no need for machine chests. In a Canadian mill with a large chest capacity and with dual consistency regulation, the basis weight still fell in the ±5% variation group.

One of the members of the committee passed out diagrams of his machine system and asked for criticism of his setup, due to the difficulty in maintaining the basis weight on heavy grades. A member of the group suggested shutting off a portion of the Vortraps in the system when operating on heavy grades to improve basis weight control.

Many of the participants in this discussion seemed to feel that the whole subject of consistency regulation would make an ideal subject for a committee session. It should be possible to develop a panel meeting bringing in the manufacturers of regulators together with the mill men for a very informative meeting. NOEL R. PHILLIPS, *Chairman*

Papermaking (Cylinder) Committee

A meeting of the Papermaking (Cylinder) Committee was held at TAPPI headquarters, 155 E. 44th St., New York, N. Y., on November 6. In attendance were: L. R. Ayres, W. B. Csellak, E. A. Crawford, G. C. Ehemann, P. Smith, and S. Weber.

Final plans for the 1954 Annual Meeting program were made. Complete details are to be published in the January issue of *Tappi*. Keynote of the meeting is to be "Finish," and the theme adopted is "Smoothness of Paperboard Including Both Visual and Printing Smoothness."

The following were agreed upon as factors affecting smoothness: lumpy formation, felt marks, wire marks, foreign matter (shiners, slime spots, etc.), fuzziness, interfiber voids, compressibility, surface voids (including scabs and surface picks), check, crush, cockles, and mechanical damage (including press cuts and calender cuts).

In the February program the theme subject of Smoothness will be dealt with under the following aspects, each of which will be the responsibility of the members indicated:

General Scope, G. I. Renegar
End Use Requirements, T. Luey
Testing, T. Luey
Finishing, K. M. Winrich and P. Smith
Drying, K. M. Winrich and P. Smith
Wet End, Geo. C. Ehemann
Stock Preparation, Ed. Manogue
Raw Materials, A. E. Bachmann

It is planned that this program will be presented Tuesday morning and afternoon (February 16), and that on Wednesday morning a review will be given by G. T Renegar, followed by a discussion period.

Graphic Arts Committee

Charles A. Morton, West Virginia Pulp & Paper Co., Chicago, Ill., has been appointed chairman of the Graphic Arts Committee, following the resignation of F. D. Elliott, Time Laboratories, Springdale, Conn. The thanks of the members to Mr. Elliott for his past service to the committee were expressed at a meeting held on October 9 at TAPPI headquarters in New York.

Under the chairmanship of C. A. Morton, the committee plans to produce three monographs on Letterpress, Offset, and Gravure Printing. These monographs are to be written with the point of view of the paper mill man in mind, with the idea of familiarizing him with the various end uses to which his paper may be put, and with the properties required in papers to be printed by the different processes.

Mr. Morton has appointed Frank B. Lincoln, Time Laboratories, Springdale, Conn., secretary of the committee. Mr. Morton was previously committee secretary.

TAPPI-ASTM Technical Committee on Petroleum Wax

The TAPPI-ASTM Technical Committee on Petroleum Wax met Sept. 22–23, 1953, at Battelle Memorial Institute, Columbus, Ohio.

Meetings were held by seven of the eight sections at the Columbus meeting; the eighth, i.e., Section V, met at Washington, D. C., on September 29 in conjunction with ASTM. Summaries of each of these meetings, which are self-explanatory, are given below.

Section I—Strength Tests

J. W. Padgett, Chairman
D. R. Cushman, Secretary

The following old business items were discussed and actions taken as indicated.

(1) *The effect of mold release compound on the tensile strength of waxes.* A review of the report by Esso Standard Oil Co., indicated no significant differences in the case of paraffin waxes, but that with blends of small percentages of microcrystalline wax in paraffin wax, tensile strength values were lowered significantly when using the Dow Corning No. 7 Silicone Grease as the Mold Release Compound. The committee agreed that further work should be done to establish whether this effect is due to solubility of the silicone mold release compound in the microparaffin blends.

(2) *The effect of humidity, during the time of pouring and cooling test specimens, on the tensile strength of paraffin waxes and paraffin microcrystalline blends.* Reports by Atlantic Refining Co. and Gulf Oil Corp. were reviewed and the committee agreed that the results of the former indicated sufficient influence of humidity on tensile strength to justify humidity limits of from 45 to 55% during casting and cooling the test specimen, as originally specified in the proposed method published in ASTM.

(3) *Mold design.* The merits of the Perkins, Mellon Modified Perkins, and Modified Dow Molds, were discussed, the latter two molds being preferred. As a result, the committee voted to drop the Perkins Mold and to adopt the Mellon Modification of the Perkins Mold as a standard, with the Modified Dow Mold being retained for further study.

A future work program for the committee was set up as follows:

(1) Additional tests will be made by three different laboratories to determine whether the relatively lower tensile strength values obtained on paraffin-microcrystalline wax blends when using mold release compound, are due to the solubility effects of Dow-Corning No. 7 Mold Release Compound.

(2) Comparative tests between the Mellon Modification of the Perkins Mold and the Modified Dow Mold will be continued.

(3) Work on setting up calibration procedures for the different tensile machines is to be continued.

(4) J. R. Wright is to assume tentative chairmanship of the subsection on bending tests. A work program is being set up by this subsection to develop a suitable bending test method.

Section II—Flow Tests

H. Schindler, Chairman

Results of the most recent round-robin test on needle penetrations at 77, 100, and 115°F., were discussed. The statistical analysis prepared by Shell Oil Co. under the direction of G. P. Hinds indicates that up to a penetration of 50, repeatability and reproducibility will not exceed three points, while above 50 a deviation of about 15% could be expected.

In order to determine whether the formation of voids during cooling is responsible for part of the deviations and results at penetrations above 50, cooperative tests will be run on two samples at 100 and 115°F. using, in addition to the mold regularly specified, a mold of 2 in. in diameter.

The section was informed that the penetration procedure developed in the cooperative tests will be published by TAPPI as "suggested method."

Section V—Composition

J. B. Rather, Chairman

During this meeting there was no action taken requiring ASTM Committee D-2 approval. The following items briefly summarize the business transacted.

(1) *Discussion of elimination of stirring step on melting point of paraffin wax, in ASTM Method D 87.* The section considered the question of whether the stirring step should be eliminated in Method D 87. All of the data which have been called to the section's attention appear to indicate that there is very little difference in results when stirring is omitted. It previously has been brought out that the British do not stir in I.P. 55. It was finally decided that the chairman would prepare a questionnaire for circulation to Section V presenting various pros and cons on this question, with the objective of reaching a definite decision as to what action should be taken.

(2) *New melting point methods.* The chairman pointed out that Section V is still interested in accumulating information on new methods for determining melting points of paraffin, microcrystalline, and blended waxes, but at the present time does not contemplate any cooperative work on that subject. At the June 29, 1953 meeting, it was decided not to investigate cooling curve methods for wax melting point, at this time.

(3) *Future meetings.* Considerable discussion took place with regard to where future meetings of Section V should be held. At the present time, the section usually meets twice a year with ASTM Committee D-2 and only once with the TAPPI group. There is some feeling that more of the meetings might be held with the consumer interests. The chairman was instructed to prepare a letter to the members of the section in order to determine majority opinion regarding this matter.

Section VI—Wax Blocking Point

H. F. Hitchcox, Chairman

The cooperative blocking results from fourteen laboratories on seven waxes and a "calibration" waxed paper were reviewed. The calibration strip was waxed at one laboratory to eliminate coating variables between laboratories. This product gave a very sharp blocking point and thus facilitated selecting the spot where blocking occurred. Eight out of thirteen laboratories reported a 101 or 102°F. blocking point on this sample. The remaining five results deviated as much as 3°F., pointing out the need for a better or more frequent calibration of the blocking plates.

Blocking tests on the waxes showed a 1.6°F. standard deviation for the air-cooled waxed papers as compared to 1.8°F. in the Spring, 1953, tests. However, the water-cooled waxed papers, which are more typical of end-use conditions, gave a 3.4°F. standard deviation as opposed to a 1.9°F. deviation last Spring. The poorer results in the recent tests are believed due to the particular waxes tested rather than to measures which had been taken to standardize the test conditions. In any case, the principal discrepancies in blocking points with the water-cooled strips appeared to stem from the waxing operation.

The following action was taken by the committee:

1. Work teams were drawn up to investigate waxing variables such as (a) coating weight vs. chilling rate, (b) time of immersion in water bath, (c) waxing temperature versus max melting point.

2. In addition to the "blocking point" (50% film disruption), a "pick point" will be indicated. This is defined as the lowest temperature at which marring, picking, or sticking occurs.

3. The procedure will be submitted for publication as a "Suggested TAPPI Standard." It is realized that the method needs improvement but it is better than the current TAPPI blocking test and is believed basically sound.

Section VII—Sealing and Laminating

G. C. Borden, Jr., Chairman
J. H. Kirk, Secretary

Results of the last round-robin test on sealing strength of paraffin wax, including statistical analysis of the data, were reviewed. The precision of the method was indicated to be poor, although possibly sufficient to distinguish significant differences in waxes.

Further work, to be completed before the next meeting, will include recalibration of instruments and checking results, by laboratories whose data are appreciably above or below average values. Also, in view of the effect of the angle at which the laminated plies are separated, arrangements were made for those laboratories having suitable equipment to run tests at a 60 to 65° angle of separation for comparison with results at 180°.

Section VIII—Gloss and Scuff

George P. Mueller, Chairman

Gloss. The chairman again reviewed for the members of the section as well as all those present the past work of the section on this subject. It was pointed out that this work showed that there was no presently available glossmeter which was satisfactory for the purpose of rating the high gloss of waxed papers presently produced. The chairman reported that apparently due to a misunderstanding between James Clark of the TAPPI Testing Division and the representatives of Committee M, the research work which was to be initiated on this subject has not yet been begun.

The chairman then informed the committee that at a meeting of the Advisory Committee on the previous night, it had been decided to again approach Mr. Clark with our request for research work on this subject, but to do it through official channels as outlined in the *TAPPI Year Book.* It is anticipated that this work will be initiated in the near future.

Scuff. The chairman distributed copies of the data which had been received from the members of Section VIII. While there were significant differences among laboratories on results obtained for individual waxes, every laboratory except one was able to determine significant differences between waxes using the Marathon scuff tester. These results are quite encouraging, since the differences among laboratories could have been due to minor differences in test instruments, as well as to the effect of weather conditions upon the aging of the waxes.

It was therefore decided that the chairman would again pre-

pare a series of samples using the same waxes tested in the last round-robin test. Before submitting these samples to section members, however, the chairman would pre-age the samples a week or more at a 105°, until the samples reach the desired degree of stability. It was agreed, moreover, that each section member would scuff $3^1/_2$ in. of sample. Since the major differences in test results took place at the laboratories of Shell Oil Co., Atlantic Refining Co., Texas Co., and Fibreboard, these laboratories will submit their scuffing blocks to the chairman for examination, and possible modification. The next round robin will not be initiated until those four sets of blocks have been examined.

It was further agreed that should there be sufficient time, the chairman would send out 2 lb. each of the four waxes to be examined, to each member for individual application and testing.

Section III—Oxidation

G. P. Hinds, Jr., Chairman

Results of the last two series of cooperative tests on peroxide number determination method were presented and discussed. In general the data indicated that the reproducibility of the tests between laboratories is in the order of ±15 to 40%, which is in the range obtainable in one laboratory at the peroxide number levels in question. Some laboratories obtain better precision than this on a few samples but whenever a large number of samples have been run, the reproducibility appears to be almost as poor as that obtained in the cooperative tests.

Several possible means of improving the reproducibility of the method were considered including increasing the peroxide at the termination of the test, and using criteria other than peroxide number for determining the beginning of the induction period.

The following action was agreed to by the committee members. All members will run peroxide versus time curves on several waxes of their own, using the latest accelerated oxidation procedure and latest version of the peroxide method. These curves will cover the range of from 5 to 60 peroxide number. Also on the same waxes, samples will be withdrawn and tested qualitatively for aldehydes by a specified procedure; the small samples withdrawn will be smelled in order to determine the time at which the wax develops a strong oxidized odor. Mr. Wheeler of The Texas Co. will distribute to each of the committee members a sample of wax on which the same information will be obtained, i.e., peroxide curves and aldehyde and odor tests. It is felt that this program should provide information of two types: first, whether or not the shape of the peroxide number vs. the time curve is the same for all fully refined paraffin waxes; and second, if the reproducibility of the present oxidation and peroxide number techniques is sufficiently good when a peroxide number level of 50 is used as a criterion for the induction period of the wax.

Section IV—Sensory Tests

L. A. Shipman, Acting Chairman

In the absence of the section chairman, G. D. Fronmuller, the committee summarized the results of the two test methods investigated on the last round robin. Numerical averages of tests (on a 1–4 basis) from all participants showed that both methods were comparable and satisfactory for detecting odor in wax.

Action by committee was taken as follows:

It was moved, seconded, and passed that a method for odor testing be accepted of—

(a) Smelling fresh shavings of wax at room temperature, and that any odorless foil, film, onion skin paper, or glassine be used to receive the shaving for test.

(b) That an instructional test method be issued to committee members based on (a) above, and that the method of rating be changed to a numerical system of rating odor intensity, providing for individual ratings as decimal fractions.

Such system to be:

1. Odorless.
2. Slight odor—not objectionable.
3. Moderate odor—objectionable.
4. Strong odor—objectionable.

No classification as to type of odor would be included in the rating.

The above is in accordance with committee purpose to present a test method for evaluating odor. The establishment of odor standards will be considered a matter of refiner-supplier relations. W. J. Yates, *Secretary*

RECENT BOOKS

Foams: Theory and Industrial Applications. By J. J. Bikerman. Reinhold Publishing Co., New York, 1953. Cloth, 6 × 9, 348 pages. $10.

This volume was prepared to bring a semblance of order out of the chaos of the literature relating to the causes and effects of foams. It is written by Mr. Bikerman in collaboration with R. B. Booth of American Cyanamid Co., J. M. Perri of the National Foam Co., and C. C. Currie of the Dow Corning Corp.

Most of the book is devoted to the chemical and physical properties of foams, including such chapters as formation and structure of foams; methods of measuring foaminess; foam drainage; mechanical, optical, and electrical properties of foams.

The remainder of the book deals with the important application of foams in such fields as fire fighting and ore flotation. References are made to paper coating mixes and to papermaking foams and ways that they are combated. The first chapter deals with chemical antifoaming agents.

College Placement Directory. By O. T. Zimmerman and Irvin Lavine, University of New Hampshire, Dover, N. H. Industrial Research Service, 1953. Cloth, $6^1/_2$ × $9^1/_2$, 431 pages. $10.75 ($11.50 outside U.S.A.).

Messrs. Zimmerman and Lavine have made another useful contribution to industry. The College Placement Directory is a service to both schools and industry. It attempts to answer two important questions: (1) for the student—Where I can find a job? and (2) for industry—Where can we find the best-qualified college graduates for the openings that we have?

The book makes available important information concerning over 1000 companies who hire over 50,000 college graduates each year. Information about companies, including many paper manufacturers, includes the nature of the business, location of plants, total employees, graduates hired per year, training program, college recruiting program, personal interviews required, whom to contact, and types of jobs open.

There is a job classification section showing kinds of engineers desired, a geographic distribution section, and a college section giving the names of placement officers and department heads.

Note: Books mentioned in this column may be obtained from the Book Department of the Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Empire State (Central District)

The second monthly meeting of the Central District of the Empire State Section was held at the University Club, Syracuse, N. Y., on November 6. A social hour preceded and 104 attended the meeting.

Harry Gray presided as chairman and introduced the following men from the head table: E. C. Jahn, director of research, State University of New York, College of Forestry; A. E. A. Van Rhijn, chemical engineer, Van Gelder Zonen N. V., Royal Paper Mills, Renkum, the Netherlands; Philip Goldsmith, Pusey & Jones Corp.; H. D. Cook, past chairman of the Central District; and F. W. O'Neil, vice-chairman, head of the Department of Pulp & Paper Technology, College of Forestry. Mr. O'Neil introduced the speaker of the evening, Harold A. Norseen, sales enginer, Pusey & Jones Corp., who spoke on "Cylinder Machine Systems." A brief and lively discussion followed his talk.

S. E. Church, *Secretary*

Stock Flow on the Cylinder Machine

Harold A. Norseen

This was to be a talk on the stock flow in the entire cylinder machine system. It was decided, however, to localize it to the approach flow and the flow in the vat circle. This was done because the flows in the other parts of the system could not be considered of direct papermaking importance except that there be the required capacity in the piping and the necessary care observed so there would be no cascading air entrainment. The subject of stock flow was chosen because its handling is all important in the success or failure of the performance of the cylinder machine and the ability to obtain a level sheet. As machine builders it is our greatest concern when designing a cylinder machine system. When we understand the flow volumes we can design for what we have learned to be desirable velocities for good papermaking. In this way we can be sure that the cylinder machine will operate at its best which is what we want as it is the focal point in the system.

Before we can determine or calculate for flow volume we must know all that is available about a customer's intended operations regarding grades of paper and consistency, and speeds at which he intends to run these. Because of our wide experience with many mills we can usually supplement this with valuable information from our own files.

The total gallons per minute is best calculated from consistency, mold drainage, face speed, and weight of sheet. Flows for every sheet contemplated should be charted so that the design of the system will not jeopardize any of them. The calculations and charts could become complicated in a multivat system except for the fact that the sheets with the highest and lowest volume of flow will serve the purpose of establishing limits.

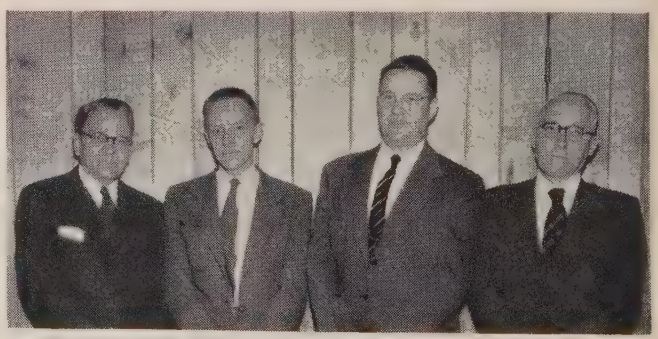
By the approach flow we refer to the flow in the section from the point where the stock leaves the single pipe to where it contacts the cylinder mold. This section includes the flow spreading arrangement and usually some part of the vat which in the Pusey & Jones stream flow vat is the outer vat circle. Since we consider the approach flow function as all important for the satisfactory performance of a cylinder machine I would like to include in this section a small portion called the making board where the stock first contacts the mold. This part in the steam flow vat is adjustable horizontally. I will discuss this feature later in the talk.

I want to discuss the approach sections in the order of flow. Of the many methods I should only discuss that of Pusey & Jones design, but if there is sufficient interest in a general discussion on this subject, please do not hesitate to express your own ideas. The trend has been to have the exit from the flow spreading equipment a continuous opening so that an undisturbed flow is presented to the mold. The Pusey & Jones flow spreader spreads the flow from a single pipe by gradually widening while progressively reducing the total area. This in theory permits control of the flow because no energy is released. If we should increase the area the subsequent release of energy would create turbulence. It can also be expressed by saying that when the velocity is decreased energy is released and turbulence will result.

For a wide paper machine or cylinder machine running at high speed it is required that large volumes of stock be spread across the machine and for this a multiple pass flow spreader with three sections must be used. This is because a single pass flow spreader could not be made long enough to gradually spread the flow. When using the multiple pass flow spreader we have change of direction of flow and a turbulence chamber at the end of each pass, and at this point it is permissible to increase the area before the next pass and gradually reduce the area at the end of the pass. In this way it is possible to have a relatively wide opening at the end of the flow spreader so that the velocity from it will not be too high.

Of course, the flow spreader will not perform satisfactorily if the velocity is too high. The same I believe is true of any equipment designed for this purpose. There has been much criticism of various schemes and designs of flow spreading equipment, but the criticism has usually been directed at an application on a fourdrinier where the usual caution regarding velocities was not observed by disregarding the increase in the volume to be handled.

The approach flow in the Pusey & Jones stream-flow vat is in the outer circle of the vat. The flow into the outer circle encounters an abrupt and desirable change in direction as it enters this chamber from where it travels to the dam.



Phillip Goldsmith, Pusey & Jones Corp.; E. C. Jahn, College of Forestry; H. A. Norseen, Pusey & Jones Corp.; and H. M. Gray, Oswego Falls Corp.

Harold A. Norseen, Sales Engineer, Pusey & Jones Corp., Wilmington, Del.

It was previously mentioned that at the "dam" or "making board" where the stack encounters the cylinder mold we have adjustability so the flow can be accelerated as it contacts the mold. This creates a desirable turbulence which tends to reorient the fibers in a random pattern. This is necessary for cross machine tensile strength in the sheet.

In the stream-flow vat you can adjust the vat circle to change the distance between it and the mold all around the circle. This will permit control of the flow around the circle, in a direct flow vat. The velocity of the flow can be made to approach the speed of the mold, thereby, minimizing the brushing of fibers in the machine direction as the fibers are deposited on the layer already formed on the cylinder.

Empire State (Metropolitan District)

About 90 members and guests were present at the Oct. 20, 1953, meeting of the Metropolitan District, Empire State Section, of TAPPI held at Fraunces Tavern in New York City, to hear a panel discussion on wastepaper utilization.

The members of the panel were Henry J. Perry executive secretary of the Wastepaper Utilization Council, Fred C. Goodwill, assistant to the executive vice-president in charge of production of the St. Regis Paper Co., and Henry Booth of the Robert Gair Co. technical staff.

Mr. Perry, who acted as moderator, described the membership of the Wastepaper Utilization Council which is composed of consuming mills, wastepaper dealers, manufacturers of inks and resins, and representatives of magazine and publishing concerns. The purpose of the organization is to improve the quality of wastepaper and increase its utilization. The first problem will be to find exactly what materials cause the most trouble. Such materials as asphalt, wax, latex adhesives heat-sealed wrappers, hot melt bookbinding adhesives, various plastic coatings, wet-strength resins, and certain types of ink cause considerable trouble in the paper mill. The council does not expect to develop means to eliminate the use of such materials, but would rather like to see them used more logically. As a beginning the council decided to concentrate on high-grade types of wastepaper, thoroughly investigating this field, and trying to work with various concerns in order to eliminate problems in the mill wherever possible. To illustrate this point, Mr. Perry described a new bookbinding adhesive that was introduced a few years ago. Although the adhesive had some excellent properties for bookbinding and greatly increased production it could not be broken down by the usual methods for handling waterpaper in the mill. Therefore, no books using this new adhesive could be used as a source of wastepaper. When the problem was brought to the adhesive manufacturers they remedied this fault by developing a new adhesive that had similar or better properties, but could be broken down in the paper mill. Another problem similar to this one developed when the new plastisol inks were introduced. These inks had some outstanding advantages over regular inks, but they could not be broken down in deinking. When this problem was pointed out to the ink manufacturers they developed a new ink, even better than the original, that could be broken down in the paper mill. By continuing such cooperation between manufacturers and paper mills, many of the problems in using wastepaper may be eliminated.

Mr. Perry was followed by Mr. Goodwill who discussed the deinking of wastepaper. Mr. Goodwill discussed a new batch process for deinking instead of the continuous process that is usually used. By this method a small batch of paper can be given special treatment when needed, and if any contamination is present the batch can be dumped without delaying total production. One of the problems after deinking is what to do with the waste material. One large mill has up to 50 tons a day of waste residue to dispose of which presents a serious problem and involves considerable expense. Mr. Goodwill felt the quality of wastepaper was improving since dealers are now realizing the need of eliminating unwanted materials. A problem that will always remain is the difficulty in recognizing new materials that may cause trouble.

Mr. Booth described a possible method for using low grade wastepaper in a board mill. This involved a series of dry cleaning, refining, and separating steps, with the clean material going into the top liner, and the secondary material going into the filler. After removing the dirt present both the top liner and filler stock are cooked, washed, and chlorinated to remove the ink present. By this type system, which is similar to a pulping operation, a good grade of board can be made starting with wastepaper containing almost any of the materials which are usually so troublesome in the board mill. Although this system is more expensive than the methods commonly used for wastepaper, it may someday be absolutely necessary to use such a system.

The talks were followed by a very lively question and answer period.

L. E. Georgevits, *Publicity Chairman*

Empire State (Northern District)

Before Henry Perry, director, Wastepaper Utilization Council, spoke to the members and guests of the Northern District of the Empire State Section on Nov. 12, 1953, it is safe to say that the majority never gave wastepaper a second thought, much less thinking of problems encountered with using wastepaper. After the meeting we were fully aware of the problems wastepaper users have and that the council has solved some of the problems.

D. Chace Mather, chairman, Empire State Section; John H. Treadwell, treasurer, Northern District; Sheldon Young, chairman-elect, Northern District; James D. Parmele, chairman, Northern District; Henry Perry, Waste Paper Utilization Council; and Richard J. Murtaugh, secretary, Northern District

Mr. Perry told us how the council began and how it has been able during its relatively short life to solve some of the wastepaper utilization problems with a resulting economic savings to those particular mills. The council is backed by paper mills, paper dealers, ink and adhesive manufacturers, plastic manufacturers, and book and magazine binders.

Wastepaper users have trouble with mill splices. The splicing compound used on flying pasters is not readily dispersible and causes trouble when trying to use wastepaper which contains it. Wastepaper which contains a wet-strength resin presents a difficult problem.

Mr. Perry said that, "Basic identification methods for wastepaper by which the user can, with certainty, establish the type of wastepaper he is using are badly needed." Along with these identification tests a program of educating the people who come in contact with wastepaper is needed.

A question and answer session followed the talk.

Richard J. Murtaugh, *Secretary*

Ohio

The November 10 meeting of Ohio TAPPI consisted of a joint meeting with the Miami Division of the American Pulp and Paper Superintendents Association, which was held at the American Legion Hall in Middletown, Ohio. Two hundred and thirty-four members and guests were present to hear a panel discussion on "The Reuse of White Water."

Chairman John Clouse welcomed the members of the Superintendents Association, and the response was given by George Lydick, who is chairman of the Superintendents. Also introduced to the group was Dean W. Newell of the Philip-Carey Corp.

The Program Committee Chairman William Aiken, announced the December 8 meeting, which was held in Middletown, Ohio, at the American Legion Hall, and featured a talk by C. A. Sankey of the Ontario Paper Co., who spoke on "Radioisotopes in the Paper Industry."

Russell Clark of The Mead Corp. introduced the members of the panel who presided during the evening. Art Thurn, supervisor of wet end and white water control department at the Champion Paper and Fibre Co., acted as moderator of the panel. Members of the panel were Herb Smith, technical director of the Chillicothe Div. of the Mead Corp., Chuck Hill, chemist with the Sorg Paper Co. at Middletown, and Russ Vanatta, who is plant manager at Excello Products Co. at Cincinnati. Prior to the meeting, the panel passed out a list of subjects for discussion, and the problem consisted of a consideration of questions previously prepared by the panel and additional questions submitted during the meeting on these various subjects. The subjects for discussion were listed as follows: (1) quality and control, (2) dirt, (3) slime, (4) foam, (5) sizing troubles, (6) reuse, (7) sprays, (8) showers, (9) filters preceding point of reuse, and (10) centrifugal cleaners.

Moderator Art Thurn opened the program with the following remarks:

"Years ago it was considered impractical to reuse white water. Gradually, competition among the manufacturers increased and the margin of profit became smaller. Today, it is recognized by many mills that the reuse of white water is necessary to maintain a favorable financial balance.

"The importance of water conservation is nudging us with increasing emphasis. The shop-worn expression—water is the cheapest thing we've got—will soon be forced upon some us 'die hards,' as a subject for revision.

"The cost of processing water may not be high, and it may not increase. But—when that water enters the papermaking process and becomes white water—then the original cost of the water is minor. For every gallon of fresh water entering the system, there is a gallon leaving the system. That gallon, leaving the system, carries valuable papermaking material. That gallon contains solids and oxygen demanding material. That gallon contributes to the size of the primary treatment plant which all of us are considering.

"This evening let us discuss white water. Where can we cut down or eliminate fresh water usage? Let us hear your experiences.

"Let this fundamental thought guide you. If you leave this discussion meeting and say you haven't learned something, it is because you haven't tried. You've wasted your own time. There is only one trade secret with the reuse of white water. It is this—there ain't no Santa Claus!"

Following are the list of subjects and associated questions which were commented upon by the panel and from the floor:

Quality and Control

What do you find is an effective method of determining small concentrations of filterable solids in white water?

Herb Smith stated that in his experience, a Gooch asbestos filter or Buchner funnel was best for this purpose. Chuck Hill said that there was no difference between these methods, and quoted some work from The Institute of Paper Chemistry to substantiate this statement. In answer to a question from the floor concerning the use of a centrifuge method for determining white water solids, Herb Smith pointed out that it could only be satisfactorily used on a paper machine which was operated in a relatively constant manner.

Please discuss the effects of closing a white water system on retention of fillers. What is a "fair" figure for filler retention? How does pearl filler compare with clay?

Mr. Hill stated that the retention of pearl filler (calcium sulphate) is somewhat less than clay due to a small particle size. Forty to fifty per cent was stated to be good retention for this material, and 80% retention of clay would be considered ideal, while 70% retention would be satisfactory.

What white water is fit for reuse as measured by the amount of fiber and filler content?

Mr. Hill stated that although the fiber and filler were the usually measured quantities, dissolved solids are becoming increasingly important, and that a determination of foaming tendency might be necessary.

Mr. Vanatta said that anything less than 3 lb. of filter solids per 1000 gal. would be good for reuse, and that 2 lb. per 1000 gal. are satisfactory for showers.

Dirt

With the closing of the white water system, does dirt accumulate in the product?

Mr. Thurn stated that in cylinder operation, 2.8 lb. of solids per 1000 gal. will accumulate in the white water. Two pounds per 1000 gal. accumulated in the white water are considered to be good operation and higher solids probably indicate holes in the saveall wires.

Slime

Which is most effective for slime control—chloramine or other poisons?

Mr. Smith stated that chlorine was effective for slime control, and that chloramine was equally effective, but maintained a residual for a longer time in the white water system. However, open-minded papermakers have tried several materials for slime control over the years. Anything which would reduce holes and slime spots received very favorable consideration. Chlorophenates and mercury compounds have been used extensively during the past 10 years. Every paper mill has to work out its own system for slime control. It is sometimes noted that of two paper machines running side by side on the same furnish, only one will require a slimicide.

What is the comparative cost of chloramine versus other slimicides?

Mr. Vanatta stated that Excello had slime troubles about 7 years, and that the treatment tried was alternated between a common type of slimicide and a mercury compound. After several years, the amounts of these materials used were reduced gradually to zero during the period of several months. Excello has operated for the last 4 years without the slimicide agents, and operates as long as 8 weeks without a wash-up.

In a comment from the floor, it was stated that a considerable difference in cost for slime treatment may be reasonable between a white paper mill and a boxboard mill. Closing out the white water system will increase the concentration of nutrients for slime-forming bacteria, but will also increase the concentration of the slimicide. An increase in temperature of the white water may increase bacterial growth, or if high enough, may be helpful in control. The optimum temperature lies above 140°F. where many bacteria may be killed. Increasing the white water temperature alone may be helpful, and will also contribute to good housekeeping.

Mr. Vanatta stated that Excello operates at a temperature of 130 to 140°F., and the absence of slime was thought to be due to operating at this higher temperature.

Mr. Smith was asked the question from the floor why one of two adjacent machines has slime and the other does not. In reply, it was stated that this may be due to the design of the wet end including associated tanks and piping. It was commented from the floor that slime is a relative term and that it may be serious in some grades and not in others. Food packaging has many problems including the other of odor which may rise as a result of closing the white water system.

Mr. Vanatta commented that Excello makes poorer grades than Gardner, but has no slime of any type, probably as a result of operating at a high temperature. Foam is also not a problem. An additional comment was made from the floor concerning the fact that it had been noted that reduction of slime caused a loss in basis weight for given machine conditions.

Foam

What is the effect of temperature on free spots, foam spots, and pinholes?

Mr. Hill stated that this was a difficult question. Air is held in small spheres inside the sheet, and he (Hill) had no answer to this question. Mr. Thurn said that alum is helpful in killing foam or making air bubbles smaller. Mr. Vannatta commented that no defoamers have been used at Excello over a period of time, and that most foam is man-made at the fan pump. Beaver-tail or mule-ear fan pumps have been found effective in preventing foam.

Do you find any foaming problem with well-washed pulp?

Mr. Smith stated that The Mead Corp. had no problems of this nature.

Sizing Troubles

Mr. Geohegan asked from the floor whether the 130 to 140°F. temperature at Excello was detrimental to sizing.

Mr. Vannatta replied that Excello, using 2 to 3% sizing, is experiencing no trouble. The main size tests are lactic acid and ink penetration. A lactic acid size test of 12 min. minimum is obtained. Roy Zellers of Chillicothe Paper Co. then stated that Mr. Geohegan knew before he asked that temperatures over 100°F. will adversely affect sizing.

Since an increase in pH will adversely affect sizing, what are the most common steps that can be taken to lower the pH in the white water so that sizing can be maintained?

In reply, the panel stated that hard water will consume alum and in order to maintain proper pH for sizing, more alum must be added to the beaters.

When the system is closed, how much does the concentration of sodium sulphate interfere with sizing and other characteristics?

In reply, Mr. Hill said that the question evidentally referred to the build-up of sulphate ion concentration and that in his experience, such a build-up had no effect on sizing but did adversely affect the results obtained with wet-strength resins.

Reuse

What experiences do the panel members have with regard to including white water from the press section in a closed system?

Mr. Smith said that Mead throws away the press water and some couch water to avoid hair cuts in the calender stacks. Mr. Vannatta stated that Excello returns press water to the filler system.

Has anyone used white water for cooking starch?

In answer to this question from the panel, a comment was made from the floor that such white water had been used for enzyme converted starches, but not for starches that must be cooked.

What effect can be expected from the dissolved solids build-up in the system?

In reply, Mr. Smith stated that a change in wastepaper cooking procedure at Chillicothe had been effective in changing some dissolved solids to insoluble solids, and thus reduced the build-up in the system. The feeling of the panel was that dissolved solids build-up might be troublesome, especially from the foam viewpoint.

What per cent of the total sewer flow can be reused safely?

Mr. Hill stated that assuming the use of white water on wire showers, effluent to the sewer can be cut into half, and that this probably requires high pressure-low volume showers.

Mr. Vannatta stated that the sewers at Excello are dry all day long, and that only week-end washouts are pumped to the sewer. There are two white water pits which hold 100,000 gal. each, and production with a 79-in. trim is 82 tons per day. Inclined saveall and screen water are returned to the filter system, and even drinking water is used for fresh water make-up.

In answer to a question from the floor, Mr. Vannatta stated that the sanitary sewers are separate from the mill sewers.

Sprays and Showers

What comments can you make concerning the use of white water on machine showers? What concentration water can be used?

In reply to this question, Mr. Thurn stated that 2 lb. suspended solids per 1000 gal. was a satisfactory figure for shower water. Mr. Smith stated that the most critical point for the reuse of white water was at the showers. Mead uses saveall water for the showers. Mr. Thurn further stated that as high as 40 lb. per 1000 gal. have actually been used for showers without plugging. Carl Magnus stated from the floor that white water was not satisfactory for sprays.

On a cylinder machine running linerboard, is it practical to recirculate the felt shower water back to the felt showers?

Mr. Vannatta stated that Excello uses felt water as hydrapulper make-up. Felt hairs are a problem in reusing felt slower water. The comment was made from the floor that the best place for using fresh water was in the felt showers, and that this water can be filtered for reuse.

In a mill which has a very hard fresh water supply would recirculated white water on the felt showers be advantageous?

Mr. Vannatta said that the use of white water would be advantageous because of the high concentration of salts in the fresh hard water.

Assuming that you will use white water for felt cleaning, is it better to use: (1) high volume showers at low pressures or (2) low volume showers at high pressures?

Mr. Hill replied to this question that high pressure-low volume showers were definitely better, but that his experience indicated that the showers should be angled into the felt rather than impinging vertically.

Filters Preceding Point of Reuse

What has been the experience of the group of diatomaceous earth filtration of white water?

Mr. Hill then stated his experiences with a pilot-plant using diatomaceous earth for filtration, and pointed out that this method would have been too expensive for the purpose, especially with starch in the white water which tends to reduce filter capacity.

From the floor, Jim Higgins of Ohio Boxboard gave some details of the system used at Rittman for filtering felt water for reuse on the felts. One and a half million gallons are processed per day in a plate and frame pressure filtration system. Five to eight pounds of filter-aid per 1000 gal. of water filtered are required. Both Dicalite and Johns-Manville diatomaceous earth have been found satisfactory. The filter-aid used, all goes into the board as filler.

Is it possible to filter white water to the extent that it may be used in high pressure-low volume showers?

W. J. Petter of Ronningen Engineering Sales stated that

this matter of filtration treatment was a very difficult problem, and cited an installation at Schmidt and Ault which included Bird saveall settling tanks, filters, and the addition of bearing cooling water which produced water of only fairly good quality. It was pointed out that the main objective in filtration is to prevent showers from plugging, that fibers may get through small filter openings end first, and plug shower openings by orienting across the hole. A low pH from reused water may contribute to shower corrosion.

Centrifugal Cleaners

Are centrifugal cleaners effective in removing dirt and sand from white water?

Mr. Vannatta stated that Excello had tried such cleaners, and that it is felt that they might be desirable for processing white water.

Russ Clark thanked the member of the panel for the excellent meeting which they had conducted, and Chairman John Clouse stated that the audience had been most cooperative in supplying questions and comments from the floor. The meeting was adjourned.

E. H. Shriver, *Recording Secretary*

Lake States

The Lake States Section of TAPPI opened its 1953–54 season on October 15 with a day and evening program at Eagle River, Wis. The majority of those attending the meeting traveled to Eagle River on the previous evening and stayed overnight at the Trees for Tomorrow Camp. The morning and afternoon were devoted to a program arranged by the Trees for Tomorrow Staff. The program included visits to the following: the 40-year-old Star Lake plantation where plantings of Norway pine were observed; a tour of Boulder Flats, one of the older pine plantation areas in Wisconsin; a tour of the Trout Lake nursery, where the growing of seedling trees was observed; and visits to the State fish hatchery at Woodruff and to the Rainbow Reservoir. Unusually pleasant weather and a fine program combined to make this an enjoyable and profitable day.

In the evening the group met for dinner at the Club DeNoyer in Eagle River. After dinner the chairman, R. J. Seidl, introduced the Section officers: vice-chairman, L. A. Moss; secretary, S. R. Parsons; Treasurer, John W. Bard; and executive committeemen, H. W. Rowe, Roy P. Whitney, G. H. Chidester, S. J. Baisch, and R. A. Diehm.

The programs for the year were announced as follows:

Nov. 10, 1953—Conway Hotel, Appleton, Wis., at 6:30 p.m., dinner followed by talks by four men from The Institute of Paper Chemistry and the Sulphite Pulp Manufacturers' Research League on their observations at the International Chemical Meeting in Stockholm. Harry F. Lewis will be the moderator and one of the speakers.

Jan. 12, 1954—Conway Hotel, Appleton, Wis., at 6:30 p.m., dinner followed by panel discussion on the subject of "Refining" with Reinhold Vogt of the Combined Locks Paper Co. as moderator.

March 9, 1954—A visit to the Wausau Paper Mills at Brokaw in the afternoon. Dinner at the Wausau Club followed by a forum led by George Brabender of Marathon Corp. on testing methods.

April 13, 1954—Madison, Wis., an afternoon and evening meeting. Discussion of research work at the Forest Products Laboratory. Evening speaker will be J. A. Hall, director of the Laboratory.

May 11, 1954—Appleton, Wis., final meeting of the season with golf in the afternoon and an evening speaker not yet determined.

George Kilp, woodlands manager of the Nekoosa-Edwards Paper Co., then introduced the speaker, Ernest Swift, conservation director, State of Wisconsin. Mr. Swift delivered a stimulating and timely talk on the subject of conservation. This was followed by a short question and answer period.

S. R. Parsons, *Secretary*

Chicago

Packaging needs at the retail level were discussed by Val Bauman, National Tea Co., at the October 19 meeting of the Chicago Section of TAPPI. About 50 members and guests were present at the Chicago Bar Association when the speaker presented his views on today's packaging. Presiding at the meeting was Chairman E. C. Berg, Ace Carton Corp., and the speaker was introduced by Charles Krebs, Atlas Boxmakers. Mr. Bauman first gave some of the history and the activities of the National Tea Co., which is the sixth largest in the food store chains in the United States, accounting for something like 12.7% of sales. The first point stressed by the speaker was that, in his opinion, packaging was primarily a service function to manufacturers, and he believed the packaging suppliers could very well pattern after some of the better service organizations set up by large manufacturers. He believed that by properly servicing an account, not only at the time the sale was made, but through delivery of the product and between sales, the packaging supplier proved himself ready to accept responsibility and to give his customer the benefit of his specialized knowledge in the field.

In the speaker's opinion there are three functions that the outer shipping container must serve. It must first transport the product to the point of sale. He touched briefly on overpacking, which is not only expensive to the shipper, but serves no useful purpose and often is difficult to unpack at the warehouse or retail level. Secondly, the shipping container must have display value, and thirdly, it might be used as a shopping basket or carry-out container, since so many of the supermarket stores require a sizable container to carry the finished order to the customer's car. Mr. Bauman suggested that perhaps shipping containers might have a die-cut handle somewhere in them that would not weaken the basic box structure that could be pulled out for this carry-out function.

He also believes that the advertising on the box is of real benefit to the manufacturer and that better identification could be placed on the container to aid at the warehousing level. He thought that perhaps the manufacturers could print the boxes, leaving more adequate space for code numbers dates, and various other information that it used at the warehouse and retail level. He also cautioned against using boxes that are too small or too large to accommodate the setups for handling merchandise at the retail level. For example, he reported that case lots of products such as candy bars are often too large for the retail store so that the chipboard folding carton has to be used as a shipping container to the store instead of the sturdier corrugated box. This sometimes leads to damage and to an excess of containers at the warehouse where they cannot be used except for their salvage as old cor-

Charles Krebs, program chairman; Edward C. Berg, chairman, Chicago Section; Val Bauman, National Tea Co.; and Jim Johnson, vice chairman, Chicago Section

rugated boxes. The method of sealing cases was discussed, and the speaker stressed that anything that could be done to provide an easier opening that would hold in shipment would be appreciated at the retail level. He emphasized the value of quick-opening containers.

Regarding folding cartons, the speaker gave his opinion that the picture package is a "must" for all who want to sell in the present crowded and elaborate super-market setup. Simplicity of package design is important. Bright colors are fast replacing the pastels of a few years ago since the package must stop the shopper within the space of a few feet and attract her to the package. The bright colors will do this where the pastels tend to fade into the background and the produce may often be passed up. A few samples of the work that his company had done in changing some of the more subdued labels to a new diamond-shaped trademark using the colors red, white, and blue, were displayed by Mr. Bauman. One, a shortening can, showed a 177% increase in sales when the new, bright label was introduced. Similar increases were made possible through the redesign of the labels of the private coffee label and pepper cans.

The speaker then showed a pound of butter with squares first wrapped in a wax paper and then overwrapped with parchment and inquired why it was necessary for the butter manufacturers to use this type of packaging for a producet that retails at 89¢. On the other hand a margarine producer puts out a foil-wrapped product with a foil-laminated carton in an attractive design on a 29¢ product.

The speaker's talk was brief, but a lively question and answer period rounded out the meeting, with many interesting phases of packaging and retailing being covered by Mr. Bauman in response to queries from his audience on various aspects of packaging and merchandising. Mr. Bauman believes that the shipping container should be valuable for reuse rather than being sold for salvage. Another thing he suggested was a folding carton that will have a price spot of metal laminated to the carton so changes in prices can be made without ruining the appearance of the carton. Foil cartons or glassine-wrapped packages can be erased. But the ink penetrates into the pores of the board in cartons and cannot be eradicated. It was also brought out that a dark strip printed around sides at the bottom of the shipping container might be valuable, for often when boxes were used as floor displays, mopping in the store results in distasteful-looking water marks at the bottom of the containers. Mr. Bauman believed that the printing of dotted lines to indicate how the cartons can be cut up for display would be helpful so that expensive display stands would not be necessary. He thinks the tear-strip-type box, particularly where it does not utilize the expensive tapes, would be very useful since most of the adhesives used in present case-sealing lines make it almost impossible for the warehouse men to open some of the containers without destroying them.

Pre-packaged meat is being used by National in 56 Chicago stores, and a definite trend toward increased use of this type retailing is expected in the future. However, the retailers expect that eventually the packaging will be done at the packer level.

As yet pre-packaged fruit and vegetables have not been too successful due to the large investment necessary for handling and packaging the produce. However, once the growers accept this as their particular job, a successful future for pre-packaged produce was forecast.

Frozen food was reported to be a better merchandising item now that a 10-oz. carton appears to be more or less the standard size. The original 16-oz. cartons were found to be too large for the average family unit. The cartons themselves are now made of better material and will withstand both display and use in the stores. The can has proved unsatisfactory for packaging frozen foods, according to Mr. Bauman. Frozen-food cartons need a vignette or some type of picture to depict the contents using over-all designs in bold type.

Disposable glass bottles have been instrumental in increasing his company's beverage sales and the use of a die-cut handle in the corrugated unit holding 12 bottles has increased National's unit sales considerably. Coming into prominence is the use of the stamped aluminum pans for bakery products. He believes that these will lend a great deal to the merchandising of bakery products at the supermarket level. He also pointed out that, in his opinion, the use of the expensive labor and expensive fixtures in the present-day super market would not continue indefinitely. Mr. Bauman believes that the future will see a cheaper type of shelf and some stores might even be able to utilize the corrugated cases for stacking directly on the shelves. He feels that the pricing of individual items in the cases is difficult and recommended that wherever possible packs offering the largest area for price marking be utilized. On impulse buying he reported that approximately 12 to 15% of the total sales were in the category of fancy groceries nonstaples.

In closing, he reported that his own idea for a container that would be quite useful in the retail field was a folding carton type that would fit directly into the wired supermarket basket. Such a carton, he believed, could be stored flat under the counter, and if it had handles it could be utilized by the housewife in the manner similar to the kraft shopping bag. He thought it would be sturdier, would make it easier for the check-out girl to handle, and the package could be carried to the customer's car without the excessive handling of each item.

Kalamazoo Valley

Approximately 75 technical men and superintendents were present at the second Kalamazoo Valley Section meeting Nov. 5, 1953, at the Hotel Harris in Kalamazoo.

J. J. Gillis, manager of the Martenson Machine Co. of Kalamazoo and of Gillis Engineering Co., presented a new concept of drying paper. The discussion period was lively and indicated the audience had been considerably stimulated by the unorthodox approach of Mr. Gillis.

A New Concept of Paper Mill Drying

J. J. Gillis

THE prevailing tendency to increased labor and raw material costs has made improved machine productivity an absolute necessity.

Labor costs and hence the cost of raw material as a variable in adjusting to the fluctuations of our economy have been practically eliminated, so any system or process which tends to raise production with no increase in labor of operating costs must realize that new or improved methods are the answer.

I wish to present what I consider a new approach to the drying of paper and board. However we do not feel the method is revolutionary but more of an outgrowth of our present vat dyes, ink and coating drying applications and experiments.

From our experience we feel that we can produce paper at higher speeds of better quality and more economically than the present methods of drying are capable of.

Our original conception of this drying process for ink applications dates back many years. The reason for developing this particular method being: (1) high heat transfer rates per unit area; (2) precise control, no fire or explosion hazard; (3) ease of scavenging; (4) the control of final moisture content; (5) the possibility of a condensing cycle; and (6) solvent recovery where economically feasible.

It is our idea to direct steam at elevated temperatures and comparatively low pressures onto both sides of a moving web, the web to be supported on a suitable screen. The unit would be completely enclosed to an extent which would enable us to

maintain a slight vacuum on the entire machine. We also use a higher vacuum in sections of high temperature steam applications to lower the vapor pressure and facilitate moisture evaporation.

In the process of drying there are two distinct stages, the first being the constant rate period and in the second, we arrive at a point called the critical moisture content stage.

During the constant rate period the drying is only limited by the rate at which heat is transferred to the wetted surface. Hence we have our highest temperature and volume application of steam in this zone.

Upon reaching the falling rate period the temperature and volume are gradually reduced to accommodate the falling rate of evaporation, which precludes damage to the web from overdrying.

When drying with superheated steam it can be assumed that the surface temperature is approximately that of saturated steam at the pressure used. This, however, is only during the state of constant rate and there is a rapid rise in surface temperature thereafter. The above was evaluated on the basis of steam with relatively low rates of superheat in the range of 100 to 200°.

There is an increase in surface temperature over that mentioned when using steam at superheats of 600 to 800°. This comes from the superheating of the surface vapors and is negligible as in our process they are reapplied.

Practically 90% of our experience to date has been in the drying of inks, and roll applied coatings. In all instances these were what might be termed straight drying jobs with the exception of the moisture setting or glycol inks which supposedly are handled better in a warm moist atmosphere.

We have found, however, that the application of relatively high temperature followed by the moist atmosphere to work better.

It has been our good fortune to have placed driers on practically all types of presses; letter press, aniline, gravure, and experimental lithography.

These are all what we refer to as drying jobs as it entails the vaporization and removal of a volatile solvent leaving the color and resins in a state of dryness or a condition where they will not offset or block.

From the standpoint of pure drying we feel we are limited only by the press speed possible. Our units are generally designed for the speeds and ink types desired.

On our aniline applications we are drying both water and alcohol system inks and probably at the highest speeds with the exception of newsprint.

We would normally use cooling rolls on aniline except for those machines printing milk bottle or dairy cartons which are rotary die cut and delivered in sheets. In this case there is not sufficient stock pressure to cause offsetting even when the delivery temperature is quite high.

When printing aniline on light stocks, such as glassine or foil laminates, cooling rolls are necessary, as this material is rewound and sheeted afterward.

On all driers handling glassine, foil laminates, or cellophane we make our steam application from both sides of the web. In this manner we stabilize the moisture content and prevent any tendency of the web to curl at the edges before rewinding or while sheeting.

Our first gravure unit has probably been our most novel applications to date, for the reason that the press was completely equipped with hot air driers between colors and the purpose of our installation was to do the final drying, to increase press speed, and replace the lost moisture content which was attributable to the inter-color drying.

This we did and to a large degree. Not having had too much experience at that time as to the moisture absorption of the nonmoistureproof cellophanes, we placed a 12-in. roll on the unwind of the press and started operations. In the course of rewinding that one roll we took off two and one-half larger rolls. We certainly had moisture, but too much.

I would like to digress a little at this point on the moisture retention or impregnation abilities of our drying system. We will say although it sounds a bit arbitrary that we can do a drying job, and finish with a better moisture condition than any other form of drying in common use.

We have an explanation for this which we feel is logical. In the case of coated materials which are heat sensitive we soften the coating and impregnate the sheet with steam and on leaving the drier and going over the cooling roll it condenses and replaces the lost moisture. In the case of uncoated stocks they are impregnated with free moisture and the result is the same.

The common forms of moisture determination make no distinction as to moisture type, whether free or bound. However, we have made tests on paper without cooling and found a relatively high moisture deficiency.

I wish to refer back to my remark about the two drying phases and explain that in the falling rate period I believe the maintaining of high temperature would in all probability remove the bound moisture beyond the possibility of immediate replacement, the reason being that the lowering vapor pressure surrounding the fibers would make it possible for the internal vapors to escape.

Regarding the mechanical characteristics of the paper. It has been found that the subsequent operations such as carton folding, bag making, and binding have all been improved by the presence of better moisture conditions.

DRYING OF PAPER AND BOARD

The unit proposed for this service would be comparable in most respects to our present equipment. However, it would be a complete cycle in that we would utilize the steam from its initial high temperature down to the liquid phase.

This unit would be totally enclosed and the web would be carried entirely through the drier on a suitable mesh belt. The discharge would be to drums which would gradually lower the temperature and condense the total vapors both the steam used as a drying medium and the evaporated liquid.

Steam would be applied at temperatures which could vary from 500 to 1500° according to the material, heat requirement, and the speed of operation desired.

It should be kept in mind that the evaporated vapors in turn become part of the drying medium, unlike air which when in a saturated condition must be removed.

At a temperature of 1000° the total heat content per pound of steam at 5 lb. pressure is 1533 B.t.u. This heat can be utilized to an approximate efficiency of 85%, taking into account the radiation losses from the external surfaces of the drier, the heat left in the residual liquid and that contained in the noncondensable vapors which would be discharged to the atmosphere.

The pressures used in the range of 5 to 50 lb. give all the latitude necessary for our purposes. This amount of pressure variation would make it possible for us to handle a large variety of sheet drying as to weights and types.

COMPARISON WITH PRESENT METHODS

By way of direct comparison we have a completely enclosed unit from which the radiation losses are negligible in comparison to the present drum driers.

From the standpoint of size our unit would be approximately one-third the present size, this owing to our design and high drying rate per unit area of web.

We would have no high pressure seals, no heavy bearings, no massive frames and a power requirement probably one-fifth or one-sixth that presently used.

The drums, we speak of, would always be operating at a slight vacuum hence there would be no necessity for heavy construction as used at present.

From the standpoint of drying control, such as moisture content from one side of the web to the other, the drying is

proportional to the total heat input per unit area per unit time. Our application as to temperature and volume could be segmented in such a manner that the control would be practically ideal.

This could be accomplished by varying the steam volume on any section according to the requirements of continuous, automatic moisture determinations which would be translated into mechanical action of our control valves. In this manner the total variation could be kept within very small limits.

This control would also act as a function of machine speed.

There is generally some doubt as to the economics of producing superheated steam. However, with a properly designed unit, steam can be heated to the temperatures mentioned, 500 to 1500°, with the same efficiency current in best-designs of industrial boiler equipment.

If produced in radiant superheaters as part of regular industrial boilers it would increase the efficiency of production slightly over that of the direct fired type. But the temperature would vary to quite an extent on boiler load variations.

We would advocate the use of separate fired superheaters, either coal, oil, or gas, and designed on the counterflow principle the efficiency would be comparable to any well-designed boiler. In fact the superheater could be installed as close to the drier as possible, which would have advantages on piping and other economies.

We do not feel the drier must be built as a complete unit for the purposes of proving its worth. In fact broken down into its components it can be used as a booster on present machines to increase drying capacity, also as a moisture distributing medium in conjunction with a cooling roll. It is possible to install the heat nozzles in a very small space so their application on present machines is feasible in conjunction with the drums.

In closing I would say, that based on experiments we have conducted over a period of years the savings in operating expense would be from 10 to 20% of present drying costs.

R. T. Trelfa, *Secretary*

Pacific Section

The Pacific Section met at the Winthrop Hotel in Tacoma, Wash. at 2:00 p.m. on Sept. 25, 1953, with an attendance of approximately 175. Fred Weleber presided as chairman and L. E. Hall, Jr. moderated the afternoon technical session. The following four papers were presented at the afternoon session:

"New Horizons in Water Filtration Plants," by J. R. Sheridan, Manager, Northwest Filter Co.: A new water filtration plant for the Weyerhaeuser Timber Co. kraft mill at Everett, Wash., has started operation. The plant is rated at a normal capacity of 27½ million gal. per day, with an emergency maximum capacity of 36 million gal. per day.

The plant was designed by the Northwest Filter Co., in collaboration with the Weyerhaeuser Timber Co., and is based on conventional coagulation with alum and lime, with settling basins and gravity filters. Some unique features used are hydraulic mass mixing, two annular shaped settling basins, and nine double-wash sand filters arranged as pie-shaped sectors in a circle.

A complete automatic system is included, to allow the plant to be unattended for two shifts per day. The controls provide for automatic proportioning feed of chemicals, complete automatic back-washing of filters, instituted by the loss of head at a preset point. A monitor system automatically checks each operation as called for, and if it is not completed in the preset time, the filter is restored to normal filtering operation, an alarm is sounded, and the proper warning indicators are energized to locate the trouble.

The plant has been in operation about 2 months, attended on only one shift, with operations on automatic. Data for this short interval indicate water leaving the settling basin with a turbidity of about 1 p.p.m., and the filtered water having 1 p.p.m. or less of turbidity and color. Results show plant operations to be successful, with water of very high quality being produced, and the automatic control system functioning properly.

"Operating a Base Load Modern Boileron Variable Ratios of Bark Refuse and Fuel Oil" by Erick R. Craig, Publishers' Paper Co., Oregon City, Ore.: In 1949, the Publisher's Paper Co. was faced with the problem of utilizing the low B.t.u., high-moisture bark refuse fuel from their hydraulic log barking and wood cut-up operation in a modern steam power boiler. The basic requirement was for a base load unit designed to become a part of a central steam power plant with a very high availability factor.

These requirements were successfully met through considerable research and pioneering in the development of a completely water-cooled combination fuel oil and bark refuse burning furnace.

In this type of furnace, the bark fuel is burned on an incline tubular hearth, which hearth is actually a part of the water-wall steam generating surface of the boiler, compared to the conventional type of combination oil and refuse burning boilers. This type of unit excels in many ways—in efficiency, ease of operation, and low maintenance costs. It will maintain rated capacity on variable ratios of the two fuels with instant response without lowering efficiency to load changes. There are no temperature limiting materials used in the construction of the furnace, therefore full utilization of maximum preheat air temperatures plus low furnace maintenance costs and the ability to maintain rated capacity and efficiency for a continuous operation period of 5½ to 6 months are a few of the desirable features of this installation.

Design specifications are 250 p.s.i., 500°F., 80,000 lb. per hr. normal of which 25,000 to 40,000 lb. are generated from the refuse fuel.

"Everett Pulp and Paper Co's Expansion and Modernization," by Charles W. Cassell, Chief Engineer, Everett Pulp and Paper Co., Division of Simpson Logging Co.: A 50% increase in sulphate pulp and 30% in paper machine capacity were effected without interrupting production.

This entailed substantial revamping of the screening, bleaching, and wastepaper deinking departments, and the addition of an 80,000 lb. per hr. B. & W. Stirling boiler, and 800 c.f.m. I-R XLR air compressor, two 2000 cu. ft. digesters with external circulation, and three 6000 sq. ft. black liquor evaporators. The wood preparation plant was completely rebuilt to provide complete flexibility in handling both virgin and waste-wood supplies. A four-stage continuous bleach plant replaced the three-stage batch system, the transition being effected in four steps so that adequate bleaching was available throughout the change-over. By shortening screen lines, capacity of existing flat screens was increased.

The 150-in. paper machine was speeded up 50% by replacement of the third plain press by eight drier rolls, the first press by a Beloit suction press, and the double-slice by a Valley inlet. Other modifications included Vortraps, Fulton drier drainage system, Ross Grewin and felt-drying systems, De-Zurik consistency regulator, Vickery felt conditioners, Nash pumps, and Sveen-Pederson saveall. A 630-hp. Elliott steam turbine was installed with a G.E. d.c. generator and a 600-h.p. synchronous machine that can either motor or generate to balance power against drier steam requirements.

Two smaller paper machines received heavier calender stacks and other refinements to enable them to relieve the bigger machine of short orders. Pusey & Jones and G.E. collaborated on the machine and drive improvements.

The mill electrical distribution was expanded to provide 2000 kva. of 4160-v. distribution to unit substations and larger motors to supplement and relieve the old 440-v. system.

Sandwell & Co. were Consultants, H. S. Wright & Co., General Contractors, and M. W. Olson, project engineer for the company.

Significant improvements in capacity, quality, and uniformity have been realized.

"The Vacuum Pickup and Transfer as Applied to No. 2 Newsprint Machine, Crown Zellerbach Corp., Port Angeles, Wash.," by T. C. Smyth, Assistant Engineer, Crown Zellerbach, Port Angeles, Wash.: One of the main papermaking problems resulting from increased newsprint machine speeds, has been the increase in "couch breaks." The use of suction rolls to remove the sheet from the wire has undergone study and a few trials during the last 30 years. In order to explore the potentialities of the vacuum pickup and transfer on a newsprint machine, Beloit Iron Works and Crown Zellerbach Corp. designed, built, and installed a vacuum pickup and transfer arrangement on the no. 2 machine at Port Angeles.

This arrangement consists of a suction roll running in contact with the wire, which removes the sheet from the wire, sticking it to the outside of the top felt. In the nip of the transfer press the sheet is removed from the top felt and laid on the first press felt. Following the transfer press are two conventional vertical suction presses.

Results obtained have been a reduction of chemical pulp (sulphite) content of about 40%, increases in machine speed of more than 10% to weekly average speeds of 1695 f.p.m., lower raw material cost because of reduction in chemical pulp content in the sheet, and reduced steam for drying to 5300 lb. per ton.

The vacuum pickup and transfer offers promise of production increases as high as 35% on machines built to take advantage of the full potential to the pickup. Installations now under way and planned indicate that this arrangement will be an outstanding step forward in papermaking technique.

A social hour and dinner were held in the Winthrop Hotel following the afternoon meeting. A. H. Hooker addressed the group following dinner on the subject "Pulp, Paper, and Politics."

H. B. Petersen, *Secretary-Treasurer*

Maine-New Hampshire

The Fall meeting of the Maine-New Hampshire Section was held at the Lafayette Hotel, Portland, Me., on Oct. 23–24, 1953. Approximately 150 people registered for the two-day symposium and approximately 200 people attended the banquet and dinner dance held on Friday evening.

The technical program which is described below dealt with the use of additives to the paper machine to improve physical and chemical properties as well as to control foam and to get better retention.

At the banquet Friday night, brief talks were made by the toastmaster, J. J. Thomas, and by John Clouse, chairman of the Ohio Section, who was our distinguished guest. Also present for the meeting and renewing old acquaintances was Ed Lamb, formerly chairman of the Section; Ed also had a few remarks for the assembled gathering.

The program was adjourned on Saturday morning in time to enable members to attend the State of Maine football series games at Brunswick and Lewiston.

The first paper at the Friday afternoon session described the "Use of Silicate Pigments in Paper," and was presented by Louis B. Taylor, Columbia-Southern Chemical Corp. Mr. Taylor discussed principally the use of Silene E.F., a colloidal precipitated hydrated calcium silicate with a particle size of 0.03 mu. In spite of its colloidal nature and low index of refraction, this material appears to improve opacity, probably because of the formation of aggregates. It is claimed that dollar for dollar it is often as effective as titanium dioxide. Electron microscope photographs were shown to demonstrate the way in which the Silene particles attach themselves to fiber fibrils rather than being retained by simple filtration. Improvement in fiber dispersion appears to result with accompanying improvements in formation. In the case of lightly beaten sheets, increased bulk has been observed. Silene helps to retain fines and thus reduces fiber losses. It is alkaline by nature but by proper neutralization with alum, it can be used in sized papers as well as unsized. Silene E.F. is usually used in conjunction with other pigments such as clay carbonate and titanium oxide. When so used, up to 15% ash, it helps to minimize losses in burst and tensile strength due to the presence of fillers. Contrary to expectation, it is not abrasive since silene is an amorphous rather than a crystalline material.

The next three papers were all on the subject of the use of natural gums and modified starches at the wet end of the paper machine.

Robert D. McCarron of Morningstar, Nicol, Inc., discussed "Mannogalactan Additives in Paper." He stated that locust bean gum was probably the natural gum most commonly used. When added at the wet end, it is effective both in aiding filler retention and in taking the place of mechanical beating. Either less beating can be used to meet given strength requirements such as burst, tensile, and internal bond or a step-up in strength is possible at the same beating level. The mannogalactans are commonly cooked at 1 to 2% solids and added at the rate of 5 to 15 lb. per ton of fiber, depending on whether used primarily as a filler retention aid or as a substitute for beating.

Mr. McCarron described in some detail new relatively compact automatic cooking equipment designed by Morningstar, Nicol for conveniently handling gums for wet-end addition. Briefly, it consists of an automatic gum feeder and cold water mixing tank, a cooking tank and a storage tank, followed by suitable means for delivering to the paper machine.

The next paper was by M. L. Cushing, Stein, Hall and Co., titled "Natural Gum Products in Production of Papers Containing Mineral Fillers." Mr. Cushing pointed out that guar is another natural gum now being used in increasing quantities and used the term "lycoids" to include both guar and locust bean gums. He also gave illustrations from actual mill experience showing how these lycoids improve sheet strength when used alone or help compensate for the normal loss in strength in the presence of fillers. Among other benefits which may be expected are improved formation, less fuzz, a decrease in two-sidedness due to changes in the distribution of filler in the sheets, and improved filler retention,

Officers and Executive Committee of the Maine-New Hampshire Section, seated: H. E. Pratt, secretary-treasurer, Pejepscot Paper Div.; J. J. Thomas, chairman, S. D. Warren Co.; A. E. Jones, vice-chairman, Oxford Paper Co.; Back row, Executive Committee members: F. A. Strovink, American Cyanamid Co.; F. N. Sprague, St. Regis Paper Co.; Roland Martin, Fraser Paper Ltd.; and J. F. Wright, National Aniline Div.

especially in groundwood and short fibered sheets. The best place to add the gum is after all mechanical treatment has been carried out; 0.25% gum based on the fiber is usually effective.

"New Techniques for Enzyme Converting Starch" was the subject of the paper by Leonard S. Wood, Jr., of National Starch Products, Inc. He discussed the making of specialty starches for specialty enzyme conversion. He showed how substituted starches can be profitably used for making enzyme converted starch sizing solutions. If the right groups are introduced into the cornstarch molecule by mild chemical substitution, the resulting product requires less enzyme for conversion to a suitable viscosity. Less conversion means a stronger starch product. This in turn means that lower solids can be used for the size solution, resulting in a very appreciable net saving in starch sizing costs. These converted, substituted starches also show much less "setback" than converted pearl cornstarch, and consequently have longer working life.

The fifth paper of the session was given by Edward J. Heiser, Dow Chemical Co., and his subject was "Pigmented Size Press Coatings Containing Dow Latex 512K." He explained that his was primarily a progress report since the use of latex in the size press is quite new, the first trials having been made about 3 years ago.

So far the latex has been used only in combination with starch or protein adhesives, up to 50% latex. Latex being thermoplastic, it contributes to gloss on calendering. It is, of course, an excellent pigment binder and being water insoluble, helps contribute resistance to wet rub and other undesirable effects of water and moisture. Paper sized with pigmented latex coatings may serve as the final product. This sizing may also provide an excellent precoat for subsequent treatments such as varnishing, conventional pigmented coatings or full latex coatings applied by other methods. The field is new, Mr. Heiser pointed out, and many new uses for this type of treatment are to be expected as more experience is accumulated.

Saturday morning, interesting papers on the use of proteins as wet-end additives and on the treatment of foam were presented to round out a very instructive program.

"Sveen Glue" was the subject of the paper by Richard Tutt, Jr., of the Peter Cooper Corp. The Sveen process is a well-known method of aiding the retention of fillers and fines by means of specially prepared glue solutions. Mr. Tutt stated that as a result of more efficient filler retention, a number of indirect benefits result. When Sveen glue is used at the wet end, stock appears less wet on the wire, due to changes in the rate of drainage, and frequently fast machine speeds can be used. Improved distribution of fines, pigments, and dyes results in better formation and usually less two-sidedness. Better wire life is experienced as a result of the reduced quantities of clay required for a given filler content. The effects of Sveen glue carry through to the savealls, aiding in the efficiency of their operation. If the glue is properly prepared, the pH of the stock has little effect between 4 and 6.8, Mr. Tutt said, except that in the case of alkaline furnishes, with calcium carbonate filler, a pH of nearly 8 may be used. He emphasized the fact that most paper machine systems are individualistic and it is desirable to use care in choosing the proper grade of glue as well as the proper method of preparation. Sometimes the use of soaps, alum, chrome alum, or alkaline salts is indicated. It was pointed out that it is possible to add too much glue, thereby harming rather than improving results. One to two and two-tenths pounds glue solids per ton of paper is frequently sufficient for good results.

Continuing the discussion on the use of proteins, L. Franklin Leighton, Jr., of the Keratene Co., explained the "Use of Protein Condensates to Promote Retention of Fillers." Among the special advantages of "Keraton" are its effectiveness in small quantities and the ease with which solutions can be prepared. It is readily dissolved in cold water with simple

J. J. Thomas, S. D. Warren Co., chairman of the Maine-New Hampshire Section

A. E. Jones, Oxford Paper Co., vice-chairman of the Maine-New Hampshire Section

agitation, solutions of 1 lb. per gal. being commonly used. One hundredths per cent Keraton based on clay filler is effective, 0.25% for titanium dioxide, and 0.3 to 0.4% for carbonate. These quantities result in significant increases in retention, according to Mr. Leighton. The use of alum is required, with a pH of 4.5 to 5. Dispersing agents interfere with the beneficial results of these protein derivatives.

The last three papers described methods of combating the foam problem on paper machines and in boilers.

Anthony Wirpsa, E. F. Houghton & Co., explained various ways of decreasing foam, such as by mechanical means, increasing the temperature of the stock, and by chemical means. He stated that inhibition of foam by chemicals is linked with more than one mechanism, that there is no single common cause of foam, and that, therefore, each mill is a problem in itself when it comes to solving foam troubles. Mr. Wirpsa also said it is very difficult to evaluate foam reducers in the laboratory since mill conditions usually involve a number of factors. Good cooperation between mill and supplier will usually result in a satisfactory solution to most foam problems.

"Improving Sheet Formation" by the use of chemical defoamers was the subject of John E. Ward of the Nopco Chemical Co. He explained how chemical defoamers act to break up foam, whether it is true foam or entrapped air dispersed in the stock. He stated that frequently stock consistency in the machine chest can be evened out by destroying foam which may be causing flotation of the fibers. Defoamers are surface-active agents and as such often increase the rate of draining of the stock on the wire. This can contribute to increased machine speeds. Formation is also frequently improved by the use of defoamers. Mr. Ward showed pictures of apparatus which can be used for spraying defoamers directly on the stock on the wire. This, he says, is one of the most efficient and effective methods of using defoamers at the wet end.

The final paper of the meeting was in the form of a carefully conceived and executed movie showing the "Potential Hazards" of foam, presented by Harvey E. Berg of the National Aluminate Corp. The troubles caused by foam in steam boilers were pointed out and the effect of defoamers in preventing these troubles was graphically shown. It was explained that foaming in boilers is a potential hazard in three ways: first, when surging takes place as a result of increased steam demand; second, when foaming or frothing results in carry-over of water, and third, when foam results in mist which causes small droplets of water to leave with the steam, resulting in wet steam and other troubles. The movie clearly demonstrated how each of these hazards can be prevented from doing harm by the intelligent use of the proper defoaming agent or foam inhibitor.

H. E. Pratt, Pejepscot Paper Div.; J. F. Wright, National Aniline Div.; F. N. Sprague, St. Regis Paper Co.; Mrs. Calkin; J. B. Calkin, Foster D. Snell, Inc.; Mrs. Jones; A. E. Jones, Oxford Paper Co.; Mrs. Thomas; J. J. Thomas, S. D. Warren Co.

Natural Gum Products in the Production of Paper Containing Mineral Fillers

M. L. Cushing

Over the last few years there has been available to the papermaking industry a series of products comprising hydrophilic natural gums, galactomannan polymers, treated with certain chemical additives which aid in dispersion and flow distribution to various stages of the papermaking process.

Merchant L. Cushing, Chief Chemist, Paper Laboratory, Stein, Hall & Co., Inc., New York, N. Y.

Table I

50 lb. coating raw stock: 8 × 8-in. handsheets. Fiber furnish: 55% bleached southern kraft; 45% southern pine groundwood. Filler: calcium silicate; R. T. Vanderbilt-Vansil. Lycoid: 1.25 pt./100 pt. filler.

Lycoid	*% Fiber furnish*	*% Filler*	*pH*	*% Filler*	*% Retention*
No	85	15	9.2	6.0	40
Yes	85	15	9.2	8.8	59
Yes	75	25	9.4	18.6	75

Per cent retention is one-pass retention = $\frac{\%\text{ filler in moisture-free sheet}}{\%\text{ filler in total furnish}} \times 100$

These products are commercially available under the generic or trade name "Lycoid"* and are sold in various color and viscosity grades to suit the individual operation. They are available in various "cold swelling" and "heavy" or "thin" boiling formulations.

A particular application of the ability of Lycoid products to increase strength factors of paper is in the production of sheets containing mineral fillers, such as clays, carbonates, titanium pigments, and the like. The normal use of these fillers results in a decrease of internal strength. Thus a sheet containing 10% clay may have a 20% lower bursting strength, a 30% lower tensile strength, and an even greater loss in folding endurance. The use of Lycoid together with the clay partly overcomes this loss in strength and in some cases can bring the strength of the filled sheet up to the value of the unfilled sheet of the same basis weight.

Since raising the ash (percentage of filler) of a sheet while holding basis weight constant means a replacement of more expensive fiber by less expensive filler, this process becomes economically attractive if the cost of the additive required to maintain strength factors is sufficiently low. This depends

* Trade mark registered in United States and Canadian patent offices. Some of the Lycoid products and certain uses of Lycoid products are claimed in one or more of the following U. S. pats.: 2,644,749; 2,644,750; 2,644,751; 2,644,752; 2,644,762; 2,644,763; 2,644,764; 2,644,765.

Table II

32 lb. newsprint: 32 in. trim experimental machine. Fiber furnish: 85% groundwood; 15% unbleached sulphite. Filler: Georgia kaolin clay. Lycoid: 1.25 pt./100 pt. filler.

% Fiber furnish	*% Filler*	*Lycoid*	*% Burst*	*% Tear*		*% Tensile*		*% Wet tensile*	*% Ash*
				MD	*CD*	*MD*	*OD*		
100	..	No	100	100	100	100	100	100	...
80	20	No	90.6	93	86	92	95	84	7.8
80	20	Yes	91.9	99	95	122	97	108	7.6
70	30	No	76.9	97	82	95	84	84	8.8
70	30	Yes	97.3	102	95	107	90	102	9.3

Per cent wet tensile measured by a homemade modification of the Brecht wet tensile tester from strips off the couch roll.

Table III

30 lb. catalog: 25 × 38—500 217-in. trim; speed 1010 f.p.m. Fiber furnish: 65% groundwood; 35% bleached sulphite. Filler: air-floated clays, mixed origin. Lycoid: 1.20 pt./100 pt. of filler. Clay/Lycoid added at fan pump at 15% clay solids.

Reel no.	*Burst*	*Tear*		*Tensile*		*Opacity*	*% Ash*	*Brightness*
		MD	*CD*	*MD*	*CD*			
1	7.6	12	17	...	...	87	8.5	..
2	...	..	..	4.8	2.0	87	8.9	59
5	6.3	13	16	...	...	87	10.0	..
6	...	..	..	4.7	2.2	88	10.2	60
11	6.0	13	17	...	...	85	11.3	..
12	6.5	..	..	3.8	2.0	89	12.9	61
17	6.7	14	17	...	...	89	13.4	..
18	6.9	..	..	4.2	2.1	90	13.5	61
Spec.	6.5	12	..	5.0	...	86	10–12	57

A. E. Jones, Oxford Paper Co.; Mrs. Thomas; J. J. Thomas, S. D. Warren Co.; Mrs. Clouse; J. L. Clouse, Oxford Miami Paper Co.; Mrs. J. F. Wright; W. L. Hinds, Keyes Fibre Co.; Mrs. Martin; R. J. Martin, Fraser Paper Co., Ltd.

on the cost and type of filler and fiber furnish being used in any given mill.

Laboratory results on handsheets indicate that the use of Lycoid products materially increases the one-pass retention of filler on the sheet mold wire. Thus in an experiment in which a furnish of 85% soda and bleached sulphite, 15% Georgia kaolin clay gave a sheet with 6.3% ash by the addition of a Lycoid at 1.25 parts per 100 parts of filler the ash was raised to 7.9%. This increase in retention due to the presence of Lycoid would be of value in open systems where white water is not recirculated. Since it is known that filler retention on any given fiber increases with increased beating or refining of the stock the results of increased retention with Lycoid is to be expected as it is known that Lycoids are the chemical equivalent of mechanical refining.

The tables show the results of a few laboratory and mill trials using Lycoid as an aid in making mineral filled papers.

In these and other runs, both in the laboratory and in various mills, there is always a marked improvement in formation. Printing stocks are improved due to less lint or fuzz and a more level sheetmaking for better printing roll impressions both before and after coating.

In every case where Lycoids have been used with mineral fillers there is a decrease in sheet two-sidedness due to more uniform distribution of filler in the sheet. This is not an unmixed blessing in the case of dyed or colored sheets. Here it appears that the increased filler retention, coupled with the change in fiber surface brought about by the presence of the Lycoid colloids, causes a change in the shade of the sheet. This is particularly noted in cases where the mill is using two dyes together to produce the required shade. This is a problem which can be solved with the cooperation of mill, dye manufacturer, and Lycoid supplier.

The use of Lycoid as an aid in producing sheets with increased filler is most effective with a short-fibered, high groundwood furnish. The amount of Lycoid used is recommended as 1.25 parts for every 100 parts of filler. This may be varied depending upon the percentage of clay on the fiber furnish. If a high filler content is held in the sheet the amount of Lycoid can be reduced since beyond a certain point added Lycoid does not proportionately increase the strength.

The point of addition best calculated to show the full value of Lycoid is after all mechanical work on the fiber has been completed. The Lycoid containing clay slurry can be added at fan pump, regulator box, head box, etc. If added at beaters or before refiners the maximum value is not obtained. Suitable modifications of Lycoid are available for use in instances where difficulty arises due to pH, coagulation of lower grades of clays, incompatibility with dispersants, fine screens, etc.

In closing we wish to credit J. H. Heuer of the Great Northern Paper Co. with having done the preliminary pioneering work on the use of Lycoid as an aid in making mineral-filled papers. His results opened up the prospects of this field of application which we are continuing to exploit.

New Techniques for Enzyme Converting Starch

L. J. Wood, Jr., and J. R. Mazeau

Since the early days of enzyme treatment of starch, great strides have been made in the manufacture of enzymes. From the expensive poorly controlled bulk enzymes, we have come to accept as natural, present-day enzymes with exactingly controlled strengths, marketed in convenient, economical capsules and pellets which provide uniform dependable conversions.

Other advances have been made in technical methods and equipment. Most modern mills now have automatic control equipment which provides a dependable conversion cycle, eliminating one of the biggest variables in this type of conversion.

On the other hand, starches for enzyme conversion for size press application have for many years remained relatively the same, being manufactured by pH adjusting regular pearl cornstarch. Some slight improvements have been made in the type of pH adjusting materials and in quality control, but basically they are still the same. Actually, until recently, there has been no need for advancements in starch manufacture for this field because enzymes and conversion methods were so poorly controlled as to neutralize those advantages which might economically be incorporated into the starches. However, since this has now changed, there grows an ever-increasing need in this rather neglected field for materials definitely superior to the regular run of starches in other words, specialty starches for specialty enzyme conversions.

Before discussing those desirable characteristics which might be incorporated economically into starches for this purpose, we would like to review one of the basic principles of the characteristics of starches when enzyme converted for size press application. In general, this principle is relatively well known. Nevertheless, it has been ignored by the majority of mills because either the starches with applicable characteristics were not available or the additional equipment necessary to handle starches in any other but the regular manner was expensive and conversions difficult to control.

We refer primarily to the well-known principle that the adhesive strength of a starch solution varies directly to the degree of conversion whether by enzyme, acid or other means. Therefore, to take an actual example, if a given starch is enzyme converted at one time with 4 tablets of enzyme and

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another time with 6 tablets of enzyme, the 4-pill conversion will have the greater strength characteristics. This results, however, in higher viscosities, which in turn, cause difficulties in application on the size press and adversely affect the pickup and penetration characteristics. From the same standpoint, we can readily see that a 4% solids conversion, using less enzyme and converted to the same viscosity as a 5% solids conversion, should offer equal or perhaps even superior strength characteristics to the more converted 5% solids conversion. However, again difficulties are encountered when applying lower conversion sizes such as this due to the poor stability characteristics of cornstarch. In other words, without a sufficient amount of converting to obtain a certain degree of stability, the sizing solution tends to retrograde or thicken at a more rapid rate and as a result, causes increases in viscosity presenting problems which most mills find difficult to handle. It is obvious, however, that were it possible to make these lower solids, higher strength conversions without difficulty, it would certainly be economically sound to do so.

Due to the above mentioned, it is obvious that in order to prepare lower solids, less converted size solutions which can be applied in mills with standard equipment without making any changes, it is necessary to incorporate new characteristics into the cornstarch which it ordinarily does not possess. Naturally, a special starch of this nature is not always necessary since it is possible in some mills which are making grades of paper which do not require relatively high size solution pickup to handle either cornstarch or potato starch, when prepared unconverted, at very low solids. As a rule, however, these very low solids preparations are not applicable on offset, writing, or envelope grades of stock since the amount of pickup is insufficient even though pound for pound, the size is probably considerably greater in strength. For our purpose we will confine our remarks to size applications for the offset, writing, and envelope types.

In order to manufacture a starch which could be prepared at a lower solids conversion but which would retain the same characteristics as a more highly converted one, it is necessary to chemically modify regular starch. It must possess a less variable enzyme demand; that is, from shipment to shipment and lot to lot, it is necessary that the same amount of enzyme convert the material to the same degree time after time. It must be considerably improved in its stability to jelling; that is, the lesser converted product must retain good stability to prevent increases in viscosity in the aged size solution. It must exhibit considerably less sediment, after conversion, than is normally obtained with regular cornstarch.

In preparing a starch with these characteristics, it would be helpful also for the material not to pass through quite as severe a peak during the converting cycle and, on the average, convert more readily. A better clarity than is exhibited with unmodified cornstarch probably would contribute to improved gloss and brightness.

We would like to point out at this time that the above-mentioned characteristics are not readily obtainable by merely preconverting the starch in the manufacturer's plant by one of the common methods such as treatment with acids or with hypochlorite. More complete chemical reaction is usually necessary. New chemical groups might be substituted on to the molecular starch chain which could provide a point of attack for the enzyme to result in a more uniform breaking up of the molecular chain. These groups should also provide the improved stability and other desired characteristics. As a matter of interest, it may be noted that by the substitution of other types of chemical groupages, the starch might in turn be made more difficult to convert. It may even be possible to substitute linkages which will cause either more or less sugars to be formed during a given conversion. We bring this up merely as a sidelight to show what a variety of effects may be obtained by chemical substitution.

It is obvious also that these effects must be obtained with very mild chemical treatments or otherwise the cost of the treatment will tend to offset much of the savings. In order to present an example of the effect of such a mild chemical treatment of cornstarch, the following figures show the comparison of its stability properties in a cooked solution to regular pH adjusted pearl corn as it is being cooled:

	Viscosity in Brabender Units	
Temperature, °F.	*Regular pH adjusted*	*Special starch*
180	700	650
120	1000	800
80	Solidifies	1000
	325[a]	207[a]

[a] Jelly strength of solidified solutions at 10°C. expressed in gram weight.

While these figures have no direct bearing on the prepared size solution, they do exemplify the difference in the base starches due to the effect of the chemical substitution. It might also be noted that a study of gelatinization characteristics of these type starches shows that a larger portion of the granules gelatinized at lower temperatures, allowing early enzyme reactivity.

To see how these properties affect the enzyme conversion, if we compare two conversions at the same solids, with the same amount of enzyme and using the same conversion cycle, it will be noted that these special starches tend to show a lower peak viscosity and a greater degree of conversion resulting in a thinner size solution. In order to bring the final degree of conversion to the same point as is obtained with the regular pH adjusted pearl, approximately one fourth less enzyme is used for the special starch. This results in comparative conversion viscosities. Using these conversions, the stability of the special starch can be readily noted by the fact that when the temperature is dropped from 200° to 70°F. the special starch increases in viscosity from 100 to only 600 Brabender units while the regular pH adjusted pearl increases from 100 to a viscosity reading completely off the scale, but estimated as about 2000 Brabender units.

In order to point out the effects which can be obtained with this type of starch, the following results were found when run at one large mill making envelope paper. The conversions at this mill with regular pH adjusted pearl are usually conducted at 9½% solids (2400 lb. of starch—16 enzyme capsules). It was found that we were able to prepare batches with as much as 30% reductions, that is, down to 6.7% solids (1650 lb. starch) which remained stable upon aging and also maintained strength characteristics on the machine in every respect, and if anything, increasing pick strengths slightly. No attempts were made to reduce the amount of starch used any further though there was every indication that it was possible to do so. This mill finally settled on about a 21% decrease in starch

solids for their size press solution; that is, from the 9.5 which they had previously used to a 7.5% solids, representing a starch saving of between $1500 to $2000 a week.

In this particular case, stability was of the utmost importance in the size solution since it was necessary to pump the starch through outside lines quite some distance from the conversion equipment to the machines, and in the past, difficulty had been had even on their highly converted regular pH starch. To give an example of the comparative stability, samples of the size solution were compared after 24-hr. aging. Their regular size solution was found to jell and attempts to reduce the solids by reducing the amount of conversion of the regular pH adjusted starch resulted in a very unstable conversion which jelled after only 2 hr. aging. On the other hand, the special starch at the regular solids conversion using less enzyme, showed increases in viscosity of only around 8 or 10%. Even on the 30% solids reduction, the size solution remained fluid and increased in viscosity by only about 20%.

At another mill making offset grade papers containing relatively high percentages of deinked stock, we were able to reduce the amount of starch solids by over 20%. High strength characteristics were maintained and again considerable improvements in pick strengths were obtained.

At still another large mill making bond paper, it was found that with the special starch, the solids of the size press solution could be reduced by as much as 33%; that is, from 6 to 4%, without affecting the strength characteristics other than to show improvements in the pick strengths over what was obtained with the 6% solids regular starch conversion.

The results of these tests, along with others which have been run, indicate that it is certainly possible in many mills to reduce by 15 to 30% the amount of starch solids applied without lowering the strength characteristics and in most cases, to show improvements, particularly in pick strengths. A step such as this, of course, is only a beginning. In this case, we have been applying old knowledge to a new starch to obtain a conversion technique which, to the paper mill, represents primarily only a savings in starch consumption.

At the same time, we have tried to show that better results may be obtained with specialty starches tailormade for a specific use. However, progress in that direction is limited by qualities and economic considerations, as well as the willingness of the paper industry to pay for the increased costs of manufacturing such starches. If the industry will back the necessary development work required for this kind of program, it offers the possibility of better products with new characteristics for improved surface sizing operations.

Sveen Glue

Richard Tutt, Jr.

THE principal application of glue at the wet end of a paper machine that has developed considerable advantageous acceptance is the Sveen method of retention, discovered by Karl Sveen in Norway in the 1920's.

The most common types of papers employing the Sveen method are book, magazine, catalog, rotogravure, publication, and offset printing grades from groundwood, sulphite, and soda pulps or admixtures carrying clays, talc, pearl filler, calcium carbonate (in one instance calcium sulphide) pigments. There is considerable usage also in mimeo, bonds, litho label, and opaque waxing grades pigmented with titanium. Some additional usage is found in clay-filled supernews, wallpaper hanging, base coating rawstocks, and clay or titanium pigmented top-liner (patent coated) boxboard stocks.

GENERAL OBSERVATIONS

When the correct type and grade of glue has been properly

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prepared and matured it is continuously metered as a dilute solution to the stock between the chest and the wire at that dosage that is best suited for the particular conditions. Standing in front of the suction couch roll of a fourdrinier, it will be but a matter of seconds after the glue's introduction, that an observer will note a change in the reading of the vacuum gage. If this gage had been reading 13 in., it usually creeps up to 14, 14½ approaching 15 in. Generally, the sheet appears to have a less "wet" appearance between the dandy roll and the couch. From this it is apparent a change is taking place in the rate of drainage through the wire. Samples of this drained white water will show a marked reduction in the quantities of fine fibers, fillers, and/or pigments that have slipped through the wire meshes and a cleared appearance to this separated water is observed compared to samples taken prior to Sveen glue addition.

As the dried sheet reaches the winder an increase in basis weight is apparent requiring adjustment. When the weight correction has been made "tear-outs" from the reel of filled or pigmented grades are found to have a higher ash content, with improved opacity and brightness. When internally sized there is an increase in sizing value; colors from dyestuffs have been deepened. It is likewise apparent an adjustment downward in the furnish of pigments, fillers rosin and/or other beater-sizing materials, and dyestuffs is in order.

One extremely interesting observation occurred some years ago at a midwestern mill trying to make a hard-sized publication sheet, highly filled with clay. To carry the desired percentage of clay the mill had experienced considerable difficulty maintaining desired sizing value. With the adoption of the Sveen method not only were they enabled to secure desired opacity, brightness, and printing qualities with less clay in the stock furnish, but they obtained the required values with less rosin size.

The ability to make the same grades of paper with a leaner back-water system has benefited wire life because of the lessened abrasion thereon from reduced quantities of clay or other pigments in constant recirculation. Reports have indicated in some cases increases in wire life approaching 20%, an appreciable saving.

An examination of the sheet after required adjustments in furnish have been made usually indicates an improvement in the distribution of the fine fibers, fillers, and pigments that has contributed to better formation and printability. Further beneficial effects because of better drainage through the wire include faster machine speeds and easier drying.

The author recalls the experience of an eastern mill making mostly clay-filled sulphite printing grades. Considerable overflow of back waters, not immediately recirculated, from all their machines were collected in a common white-water tank. Some make-up water for reuse on the machines, also dumping water for beaters were drawn from it. There always had been considerable clay sedimentation therein, building up rather compactly on the bottom requiring removal by shovel-

E. J. Heiser, Dow Chemical Co.

Richard Tutt, Jr., Peter Cooper Corp.

ing on week-end clean-ups. After permanently installing Sveen the very limited residual clay in this tank was easily removed by flushing with a hose.

On occasion the subject of "two-sidedness" of colored stocks has been brought up in conjunction with Sveen glue applications. It appears to be controversial. While there have been occasional instances where the "two-sidedness" has become more pronounced upon introduction of the Sveen glue, there have been numerous other cases where just the opposite happened, marked improvements in reducing "two-sidedness" were definitely observed. The author makes no pretense of knowing anything about the cause of "two-sidedness." There always has been plenty of it, some cases more pronounced than others, before the Sveen method was ever conceived.

The effect of Sveen glue addition does not stop with the formation of the web. It carries through with the remaining suspended solids in the white water aiding in their separation and recovery and improved clarification of the white water in mechanical saveall equipment or by subsequent treatment in flotation or sedimentation type recovery systems. Reductions in quantities of filterable solids in the clear effluent from mechanical (wire screen covered cylinder type) savealls of 50 to 60%, sometimes more, are not unusual.

It is often asked as to what pH range to the paper machine system Sveen glue usage may be limited for appreciable results. When the proper type and grade of glue is properly prepared by the correct formula (with the exception of certain unfilled highly alkaline stocks) the pH of the system appears to have little or no bearing. Various stocks internally sized with rosins precipitated with alum, or alum and sodium aluminate, may range in pH anywhere from around 4.0 to 6.6 or 6.8, as the mill prefers, for their own conditions. Calcium carbonate pigmented stocks are not rosin-sized, alums are omitted, and pH ranges generally 7.4 to 7.8. So far as retention on the wire is concerned, interesting improvement with Sveen glue has been secured all the way through from 4.0 to 8.0. There are mills making publication grades heavily pigmented with calcium carbonate or combinations of clay and carbonate that have continuously used Sveen glue for retention for over 12 years.

By no means is the Sveen method restricted or limited in value to just those mills having "open" machine systems. Papermaking materials are of greatest value to a mill the first time they pass over the wire, therefore, the highest percentage of their retention that can be secured at that time leads to improved economies. The operating advantages secured with markedly leaner paper machine systems soon became apparent to a number of mills operating with so-called "closed" systems and they have continued to use Sveen glue constantly ever since.

GLUE SELECTION AND FORMULATION

It is unfortunate that many buyers, technical and supervisory mill men are not familiar with the wide range of types, grades, and difference in protein values of animal glue and the wide differences in the working performances of them for specific end usage. To those who are not familiar with these differences, existing price differentials may be confusing, but when it is made clear that these types and grades range all the way from the low jelly strength value packing house or rendering plant type of green bone glues (60 to 85-gram test) upwards through naphtha types from dried bones, to the high jelly strength, high protein valued hide glues testing upwards of 400 grams (Standard methods, National Association of Glue Manufacturers) the reason for these differentials becomes apparent.

The author working in cooperation with P. M. Loddengaard early in 1937 conducted a series of commercial trials in some of the eastern mills employing the Sveen method to determine which grades and types secured optimum results and lowest net cost per ton of paper. We learned that most paper machine systems are somewhat individualistic, each having its own variables and conditions peculiar unto itself. There are cases where conditions to be met are rather simple, plain unmodified dilute solutions of relatively low jelly strength value glues being usable. For the great majority of cases, however, careful choice of type and grade of glue with proper regard to the modification formula best suited is indicated.

Modifications of glue solutions for Sveen usage may include soaps, rosin sizings of several types, and such activators as papermaker's alum, chrome alum, and some alkaline salts. The use of alkaline salts is covered by U. S. pat. 2,403,143 and chrome alum by U. S. pat. 2,403,144.

All types and grades of glue were used in these trials. It was apparent then and has been repeatedly confirmed since that the initial price of the dry glue per pound and/or the cost per gallon of the batch does not indicate the actual cost. True measurement of cost is the volume of glue solution at 1% solids concentration required per ton of paper for optimum results with properly controlled dosages.

For the broadest range of paper machine pH conditions and types of pigments or fillers, hide stock glues of high protein value, testing approximately 225 grams jelly strength gave best over-all results with the lowest dosage rates per ton.

Higher jelly strength values than 225 grams did not show sufficient increases in retention to warrant their usage economically.

Lower jelly strength values required increased dosages dependent upon their intermediate gram test, the lowest jelly strengths (around 85 grams) generally requiring upward of 40 to 50% more glue solids per ton than the 225-gram test.

It was a common error in the field then and we frequently encounter it now, where someone assumed that just because a very small dosage of glue does an interesting job a little bit more ought to do it much better. Sometimes the "little bit more" grows into "considerable more" and control of dosage with changes in basis weights and tonnage produced is forgotten. Excessive dosages beyond those actually required are wasteful, they do not gain further retention and aggravate "foaming" on the paper machine. If allowed to get out-of-hand they can reverse the action causing dispersion rather than flocculation.

Current dosages today range from approximately 1 to 2.2 lb. glue solids per ton of paper. If it is found that greater amounts are required, the type and grade of glue and make-up formulation should be looked into and corrected.

Use of Protein Condensates to Promote Retention of Fillers

Melvin H. Diem and L. Franklin Leighton, Jr.

Several years ago The Keratene Co. sponsored some work at the New York State College of Forestry on the utilization of protein condensates in the manufacture of paper.

Melvin H. Diem and L. Franklin Leighton, The Keratene Co., Inc., Winsted, Conn.

We were interested in determining the effect of protein condensates on filler retention, rosin sizing, paper coating, and other processes where protein materials such as glue or gelatin and casein are commonly used.

Because of time limitations, I will confine myself to the use of a particular protein condensate which we call Keraton.

Keraton is a protein-fatty acid condensate. It is an amber colored liquid, readily dispersible in water. It has many of the physical and chemical properties of proteins but differs from intact proteins in being a more surface-active material.

The work at the New York State College of Forestry on filler retention was done by R. G. Hitchings and C. E. Libby. They found that Keraton would promote the retention of clay, titanium dioxide, and calcium carbonate. In the case of clay, they obtained maximum filler retention when a level of 0.1% Keraton, based on the moisture-free weight of fiber, was used. Maximum retention of titanium dioxide was obtained when 0.25% Keraton, based on the moisture-free weight of fiber, was used. When working with calcium carbonate, a level of 0.3% had to be used before any significant increase in retention was obtained.

While the results of laboratory trials are interesting, I believe you will have more interest in mill trials, and in some of our observations in applying this protein condensate with other materials used in the paper machine system.

To present an example of the results obtained with Keraton, I will give you the major details of a recent mill test where we were interested in increasing the retention of titanium dioxide.

This test was run on a 45-lb. sheet, using in the furnish 4.0% titanium dioxide and 5.0% clay, 2.0% rosin size, and 4.0% alum. Keraton was added at three points of the machine system. First, a stock solution of Keration, containing 1 lb. of Keraton to the gallon, was added to the fan pump, and then we changed the point of addition to the flow box because of operating convenience. The Keraton was added to the flow box at the rate of 0.1% based on the weight of paper off the machine. Later on, Keraton was added to the beaters at a level of 0.2%, based on the weight of fiber furnished the beater.

The Keraton test was run on no. 1 machine. Machine no. 2, running the same grade of paper, was used as a control. Samples were taken from reels of paper made on both machines, also, samples were taken of the stock entering the jordans, the head box, and second tray.

The ash and titanium dioxide in the samples were determined by following TAPPI Standard T 413 m-49 for ash, and TAPPI Standard T 439 m-44 for titanium dioxide.

The titanium dioxide in the sheet from no. 2 machine, the control, averaged 2.33%. The titanium dioxide in the sheet from no. 1 machine, when Keraton was used, averaged 2.97%. This is an increase of 27.5% over the control. The titanium dioxide in the sheet from no. 1 machine, when no Keraton was used, averaged 2.58%. Comparing this figure with the 2.97% average, the increased retention of titanium dioxide was 15.1% on no. 1 machine.

Using the amount of titanium dioxide furnished the beater as a base of calculation (4.0%) the per cent retention of titanium dioxide on no. 2 machine, the control, was 58.3%, the per cent retention on no. 1 machine, when Keraton was added at the flow box, was 74.3%, when Keraton was added to the beater, the retention was 74.7%. The retention of titanium dioxide when *no Keraton* was in the machine system on no. 1 machine was 64.5%.

A saving of 15% titanium dioxide is indicated by this test. Using a conservative figure of 10%, this saving amounted to about $1.00 per ton for this sheet.

We had an experience when making another mill test, which I would like to discuss. It illustrates some of the problems encountered in obtaining maximum retention of fillers.

This test was run on a 25-lb. opaque glassine. The furnish contained 6.5% titanium dioxide, rosin size, sodium aluminate, and alum. Keraton was added at the fan pump at a level of 0.1% based on the weight of paper off the machine. Also, additional Keraton, 0.1%, was added to the beater. The sheet was tinted with a pigment color, and it was regular practice to add a pigment dispersing agent to prevent any mottling or separation of color. For several reasons we planned to start the run without the use of the pigment dispersing agent. Later in the run, we wanted to add the dispersing agent to replace the Keraton furnished the beater. The ash decreased considerably, but the opacity was higher than at the start of the run. Samples taken later showed a further decrease in opacity, but we were within opacity standards, and no changes were made. We then removed the pigment dispersing agent. When Keraton was in the system alone the opacity and ash content returned to the general level obtained at the start of the run.

L. F. Leighton, Jr., Keratene Co., Inc.

Anthony Wirpsa, E. F. Houghton & Co.

Some reagents wet and disperse pigments so efficiently that the pigment or filler preferentially goes through the wire and recycles through the wet end of the machine system, instead of staying with the paper fibers. The use of dispersing agents, therefore, may be working against flocculation of the filler on the fiber.

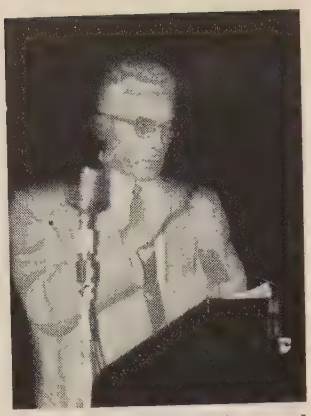
This brings up the question of why protein condensates aid in the retention of fillers. We have some theories which will be briefly touched on. Protein condensates are colloidal materials, and will form surface films on particles of diverse character. These films carry an electrical charge depending on the pH of the system. Particles "coated" or "filmed" by protein condensates are positively charged at pH 6.0 and at a lower pH. Above pH 6.0, the particles are negatively charged. We believe Keraton aids in building up the net positive charge on the fibers.

Alum is necessary to effect any appreciable increase in retention, when using protein condensates. Besides the well-known reasons for using alum for increasing retention, alum will flocculate Keraton. The colloidal suspension of the aluminum salt of the protein condensate helps to trap fine particles in the paper. So much for theory.

To promote the retention of clay and titanium dioxide, we have found that the pH of the white water system should be in the range of 4.5 to 5.0. Small quantities of sodium aluminate are helpful in aiding retention, especially if the pH of the white water system is low, that is, in the neighborhood of 4.0. Our experience in using sodium aluminate to adjust the pH of a system, led us to observe that a combination of the two materials sometimes promotes greater retention than using either material alone. Usually an equal weight of the two products, and at levels of 0.1 to 0.2%, based on the weight of paper over the machine, is used. They may be added to the machine system, in solution form, at the fan pump.

For the retention of calcium carbonate, larger quantities of Keraton are required. Four hundredths per cent Keraton,

J. E. Ward, Nopco Chemical Co.



H. E. Berg, National Aluminate Corp.

based on the weight of fiber, will give maximum retention of calcium carbonate.

Some of the advantages of using protein condensates are as follows: (1) small quantities are effective in promoting retention of fillers, and (2) solutions of protein condensates, for feeding to the mill system, can be made up quickly without the use of special equipment or heat.

Foam on the Paper Machine—Causes and Cures

Anthony Wirpsa

THE title of this paper would have interested me when I worked in a paper mill as we were never absolutely sure what caused some of our worst foam conditions, also, we were not always able to lick these conditions with the defoamer on hand.

It is possible that, if the subject of foam had been discussed more by other paper mill personnel, I could have learned more about how to overcome it. Usually, there were more pressing problems such as pitch, sizing, or the development of new products and, as a result, foam took a back seat.

At the Annual Superintendents Convention last June in Atlanta, a very interesting paper was presented by C. C. Parvin of the Nekoosa-Edwards Paper Co. The title was "Elimination of Foam on the Paper Machine." This paper was interesting as it described the studies made in building their new paper machine so that all causes of foam would be eliminated.

If any of you have observed this machine in operation, you probably have noticed that there was very little foam in the headbox or on the wire.

The discussion that followed the paper was lively as most of the superintendents had foam problems that were of an immediate nature. There was very little chance of having a new paper machine built in their mills.

Before the session, the chairman was quite concerned that the subject of foam would not be of interest to most of the superintendents. He was pleasantly surprised, as foam problems and how some men licked them were discussed until it was necessary to cut them off as time ran out.

Some of the superintendents found that increasing the consistency of the stock to the headbox alleviated some of their worst foam problems.

Other suggestions were changing of flow boxes, installation of tanks to allow foam to gather and be dissipated before the headbox, and increasing temperatures of stock.

It was interesting to note that some of the above changes did very little for another mill, however, everyone was of the opinion that much could be learned from the interchange of ideas on foam.

ANTHONY WIRPSA, Supervisory Chemist, Paper Products, E. F. Houghton & Co., Philadelphia, Pa.

Foam in paper mills can have an entirely different meaning as compared to foam in other industries.

In such industries as asphalt, sugar refining, etc., the foam is usually caused by the same agent: the degree of foaming may vary but there is usually some foam at all times.

In the paper industry, a grade of paper may be foamy one day and not the next. Some mills know the reason for this variation, while others are stumped when they try to determine the cause.

If the foaming liquids in a paper mill were of a constant nature, the methods of inhibiting the foam could probably be determined by formulas, however, as mentioned before, the foaming liquids are anything but constant in nature and, as a result, it is virtually impossible to determine by formula in the laboratory, how well one defoamer will work as compared with another.

Sydney Ross of the Rensselaer Polytechnic Institute has done considerable work on what causes foam and the action of inhibitors. In his studies he found that the inhibition of foaming can be brought about by mechanical or chemical means. The mechanical means employ pulsating streams of gas above the liquid, continuous pumping of liquid from bottom to top of container, change of pressure, heating elements, ultraviolet or x-rays, supersonic waves, rotating fans or disks, adjustable gratings above the liquid surface, or sharp corners in the design of the apparatus, with varying degrees of success.

The chemical means include the addition of a wide variety of compounds such as alcohols, mineral or vegetable oils, esters, phosphates, silicones, and many others.

Indications are that the chemical inhibition of foaming is based upon more than one mechanism. Foam inhibition has been linked by some investigators with the solubility of the antifoaming agent. They maintain that a defoaming additive should be or must be insoluble in the foaming system to which it is added. While it appears that the most pronounced foam inhibitors are in the majority insoluble, an additive need not be insoluble to be an effective foam breaker.

An important factor in the foam inhibition of an additive is its spreading property with respect to the foaming liquid. While this relationship applies only to insoluble defoaming agents, it is extremely valuable in accounting for the defoaming action of a majority of additives.

The spreading coefficient S is defined as

$$S = \gamma F - \gamma D^1F^1 - \gamma D$$

where γF is the surface tension of the foaming liquid, γD^1F^1 is the interfacial tension of the defoaming agent/foaming liquid interface, and γD is the surface tension of the defoaming agent.

If S is positive, the defoaming agent will spread on the surface of the bubbles and ultimately cause the bubbles to break. If S is negative, the additive will not spread and the foam will remain stable.

We can immediately recognize the importance of synthetic surface-active agents which can spread on either oily or aqueous surfaces. They have replaced to a great extent many of the older antifoaming agents which occurred naturally such as pine oil, castor oil, linseed oil, and similar materials.

Briefly, those are some of the published theories on foam inhibition. We certainly wish it were that simple in the paper industry.

While on a trout fishing trip this Summer, it struck me that licking foam problems in a paper mill is similar to brook trout fishing. Believe me, it's just as much fun to do one as the other. My fishing partner was an old-timer who studied all the conditions: weather, species of flies, height of water, and time of day.

From all this, he figures out *the* fly that should be most effective. I tied it on and, on the first cast, a $2^1/_2$ pounder hit it. Before the day was over, we both had the limit of good sized

trout. On the following day, we went to another stream that was supposed to be even better. We tried every fly in the book and barely caught enough for supper. How does this compare with licking foam problems in paper mills?

We make arrangements with a mill to run a trial of our defoamer. We study all their conditions, stock, water, pH, speed, and equipment. We recommend a product that worked in a similar mill under similar conditions. We run a trial and the results show we are able to kill their foam and save the mill some money. This is just as much fun as catching the limit of brook trout.

As a result of this success, we pick out another similar mill, go through all the preparations and, at the end of the trial, we find that the defoamer recommended is only fair.

One feels as futile now as the day when the trout would not rise.

All this may sound as though everything about defoamers is a hit or miss proposition. This is not entirely so, as we often obtain stock from a mill and determine in our laboratory which of our products does the best job. We are working continuously on how to measure the efficiency of foam killers in our laboratory.

To prove whether one foam killer is better than another on surface foam is fairly easy, however, to determine whether it will cause operating difficulties on the paper machine is a different story. If you mill men bear with us in supplying all the necessary information as well as stock to work with, we believe some of the guesswork can be eliminated when a troublesome foam condition occurs on your paper machine.

An interesting theory advanced by a technical director in a paper mill is that the increased use of synthetic detergents for dish washing and clothes laundering may be one of the reasons why some mills, that are located on streams below a community, have increased foam problems.

This sounds logical as many of these synthetic detergents are of a nonionic nature and will survive most sewage treatments.

The City of Philadelphia reports that in the past few years there has been a tremendous increase of foam in their sewage disposal plant.

The above idea might be of interest to some of you men in mills that are located on streams that pass through a community. If you notice an increase of foam on Monday or Tuesday or at certain hours of a day, the cause may well be from these detergents.

In conclusion, it is our opinion that more can be learned regarding foam on the paper machines and how to overcome it if more panel discussions were held on this subject.

Improving Sheet Formation

John E. Ward, Daniel H. Hall, Clark E. Snook, and Charles Lighthipe

THIS paper discusses briefly the various ways in which the use of surface-active agents can help to improve sheet formation and help make a better sheet of paper. The addition of a chemical to eliminate foam to paper stock has a number of effects in various cases, and they are certainly not all covered by the term "defoaming." Now, not every effect can be observed in all cases, but it is believed that it is important that you know the potentialities of these important papermaking aids.

First and foremost, of course, these chemicals act to defoam the paper stock. If foam is so dense in the headbox, or if it is standing so high in the vat that it actually gets into the wet sheet as agglomerates, it will cause foam spots. Particularly if you are using titanium dioxide or some conspicuous filler which tends to be concentrated in the foam, these spots would be very noticeable. The use of an efficient surface-active chemical, commonly called a defoamer, will eliminate these foam spots.

Even more troublesome than this type of heavy foam is the difficulty caused by small bubbles of air which are entrapped in the stock. As these flow out of the slice onto the wire, they displace the papermaking fibers and form actual thin spots in the sheet which are observable as light, usually circular spots when the sheet is held up to transmitted light. The use of defoamer to eliminate these thin spots or bubble spots is a familiar one. In fact, these two benefits obtained by using a defoamer are the two that first come to mind when the subject is mentioned, but there are many other benefits that can be obtained.

If, for instance, your stock is so heavily aerated that it tends to float in the chest you have a great deal of difficulty in making a uniform sheet of paper. The proper use of a chemical to deaerate the stock will allow it to mix uniformly in the chest and will help you even out your sheet weight, thus getting a better sheet of paper.

If foam is generated in the machine screens, in the headbox, in the trays, or at some other point on the paper machine, and if the amount of foam produced is a function of the machine speed, then the rate at which you can make paper will be limited by this foaming condition. The use of an efficient agent to eliminate foaming at what used to be the critical speed, will enable you to go to higher papermaking speeds. The benefits obtained in this way are very important to the production man.

These four benefits are produced solely by the action of surface-active agents in breaking up the air bubbles in the stock. Defoamers have a number of other effects on the stock and these, the less familiar ones, are the ones the authors should like to stress because they are not thought of as frequently. Most important among these secondary effects is the ability of a foam controlling chemical to improve the rate of drainage of the stock. In the cylinder machine this can be very impressively demonstrated by the drop in the level of the stock in the vat when an effective defoamer is fed into the stock system.

The extent to which the use of a defoamer improves drainage of water from the stock is harder to observe on a fourdrinier machine. The clearest way to observe this difference, of course, would be to treat part of the sheet on the fourdrinier wire and leave the other part untreated. For this reason, we have developed the demonstration machine. This consists of a tripod with cross-bracing at the base and an adjustable upright. The tripod is installed with two legs close to the front side of the fourdrinier wire, and the pump unit is placed on the bracing under the back leg to form a counter weight for the spray arm which is cantilevered out over the machine wire. This portable demonstration setup allows us to treat a 72-in. width of the sheet on the wire. I would like to emphasize that this spray apparatus is not merely a demonstration gimmick to enable us to observe the effect of treating half the sheet. It was really designed to enable us to demonstrate what we believe is the most effective way, the most efficient way of using defoamer, which is to spray it in very dilute emulsions directly onto the fourdrinier wire at a point shortly below the slice before any considerable portion of the water has begun to drain out of the stock. The amount of defoamer required when spraying at this point is generally less than if it is applied at the headbox or to the machine chest or any other point ahead of the wire in the stock handling system. In addition, the effect in improving the drainage of the stock is maximized.

This improved drainage can be observed in several ways. Generally, the boundary between the wet and dry portions of the sheet moves back toward the slice on the treated portion of the sheet. The amount of water, and in some cases actually stock, which is picked up by the dandy roll and thrown out into the air is cut down markedly. In addition,

JOHN E. WARD, DANIEL H. HALL, CLARK E. SNOOK, and CHARLES H. LIGHTHIPE, Nopco Chemical Co., Harrison, N. J.

the number of wet spots in a sheet going to the presses is reduced.

In addition to improving the drainage of the sheet, applying a dilute emulsion of defoamer as a fine spray naturally breaks all of the surface bubbles on the sheet. In many cases spray application actually smooths the sheet on the wire. It levels out the longitudinal waves that are caused by the shake, giving a much more nearly glassy smooth appearance to the surface of the treated portion of the stock. This means, of course that sheet formation is disturbed less by the shake. Corresponding improvement in sheet formation can be expected.

These are minor benefits compared to those that can be derived from improved drainage. Obviously, if the sheet drains more rapidly, more completely, the sheet will be drier as it enters the drying section. Therefore, it is possible to make paper at the same rate of speed from the same stock and to save steam in the drying operation.

Usually, though, the papermaker would prefer to take advantage of the improved drainage in some other way. For example, if the drying capacity of the machine has been the factor which has previously been limiting the speed of machine operation, he very likely would prefer to take advantage of the improved drainage by increasing the machine speed, thereby increasing production.

Or, a third alternative would suggest itself as a way of exploiting improved drainage. Rather than taking advantage of the steam saving or speeding up the machine, the papermaker may be greatly interested in the possibility of adding more water to his stock as it goes to the headbox, thus obtaining improved sheet formation. The increased rate of drainage, which is realized with the spray application, will get rid of this extra water that has aided in the sheet formation, yet will give a sheet of the same moisture content going to the driers. Thus, the spraying of the emulsion on the wire in this case actually permits the use of more water in the stock which enables the papermaker to obtain improved sheet formation. So you see, the use of a defoamer has a large number of benefits observable on the machine, and can aid you in several ways to obtain improved sheet formation.

In pulp processing, it is coming to be realized more and more that foam cuts down the effective capacity of screens, deckers, washers, and other equipment. Use of the proper surface-active agent to eliminate this foam binding effect will increase the effective capacity of the existing equipment. For this reason, the amount of defoamer used in pulp mills is steadily on the increase. A word of caution is in order here. It is not generally the best plan to add a large slug of defoamer early in the pulp processing and count on its carrying through to take care of foaming at all points in the system. It is usually much more economical to add only enough at each point where foam is generated to take care of foam at that particular point. Almost every mill, though, has a number of points in its pulp processing system where foam troubles are occurring. The use of a central defoamer makeup system with piping to these spots is the simplest way of eliminating these troubles.

In conclusion, the authors would like to point out that because of differences in furnish, in stock preparation, and in machine tending, the use of defoamer cannot be expected to produce in any given sheet all the benefits that have been mentioned. However, it is believed, that if you will look for these other benefits in addition to simple bubble bursting when you use a defoamer, you will be interested to see the number of ways in which the use of a foam controlling chemical can give you a better sheet. The defoamer acts by breaking up heavy agglomerates of foam in the headbox, removing entrained air in the stock, increasing the capacity of pulp handling equipment, permitting increased machine speeds, improving drainage, and aiding sheet formation. There probably is no person in this room who is not interested in steam economies, in increasing hism achine speed, or in improving his sheet formation and it is believed that the proper use of defoamer will aid in the attainment of these goals.

Introduction to Film, "Potential Hazards"

Harvey E. Berg

The problem child, foam or froth formation, is troublesome in many industries but probably causes more different kinds of difficulty in the paper industry than any other industry.

Previous speakers have pointed out where foam or froth difficulty, which can be corrected with defoamers, can occur in the paper industry such as bubbles causing voids in the paper, reduction of chest capacity, drainage, ineffective pulp screening, and others. An additional place in paper processing where defoaming action can be beneficial is in a pulp thickening process where inconsistent dewatering as the result of froth causes the problem of consistency control in the thickener stock chest. This can at times be a serious problem.

Regardless of the industry, there are some things common to all foaming systems. All air-gases or vapors passing through a liquid must escape in the same manner. If the film of liquid, surrounding the gases passing through the liquid, is fragile, the film will rupture on reaching the surface and will release the gas. If, however, the film has been stabilized by some contaminant or material used in the process, the film will break slowly, if it breaks at all, resulting in buildup of foam or froth.

A paper mill when considered as a potential foam producing system is more complex than any other industrial operation. For example, the beet sugar refining system experiences very severe foam conditions and the severity varies principally with the quality of beets. The paper mill not only has the quality of wood as a variable, but consideration must be given to the water quality and many different materials of furnish, each of which may be foam inducers or liquid film stabilizers.

Mechanisms of defoaming action which have been suggested are: *penetration*, rupturing of a film in the same manner a pin will rupture a rubber balloon filled with air; *spreading*, causing drainage of water from the film causing it to become thin and fragile; *displacement* of film stabilizing material in the film; or *film condensation* causing parts of the film to become brittle and fragile when stresses are applied. Our work indicates that one or more of these mechanisms must be provided by an effective defoamer and to borrow a term from the medical profession, "synergistic" phenomena can be observed in which one material aids another to make the two more effective than the simple additive effect of the two. This may be due to each furnishing a different mechanism of action.

There are two generally observed phenomena of antifoam action which are important to the paper industry and should be considered when selecting a defoamer. These are "bubble coalescence," forming larger more fragile bubbles which are more easily separated by fibers and break without formation of froth and "bubble rupture," which involves breaking the film and releasing the gas. In a recent publication of the paper industry, a representative of a pulp thickening equipment firm indicated that small bubbles of froth interfered with dewatering while large bubbles were not nearly as objectionable.

In the film, "Potential Hazards" these phenomena are demonstrated, and although the laboratory studies pictured were not made in our paper laboratory, the principles demonstrated apply to the paper industry as well as other industries.

Harvey E. Berg, Manager Process Chemicals, National Aluminate Corp., Chicago, Ill.

Control Method Developed for Stock Preparation System

J. H. PEARSON

For the past several years paper mills have been plagued with constantly increasing production costs. There have been many new designs of mechanical equipment to combat these increased production costs. This new equipment has been able to process the raw material faster than ever before. To realize the ultimate in production from this new equipment, automatic control means have been sought. Paper mills have recognized the advantages of automatic control as a means of obtaining the following: (1) greater production, (2) higher quality, (3) reduction in man power, and (4) savings in electrical power.

We have been actively engaged in the design of automatic equipment for the past 14 years. During this period, we have had some interesting problems in control and design. It is the purpose of this paper to present a few of the most interesting designs. Two of these methods have not been field tested, however, we would like to pass along these methods for consideration—perhaps one or more may apply to your mill.

WATER REGULATION IN CLEANING SYSTEMS

For years white water regulation in filler stock systems has had need for automatic control. The present consistency regulators available to the industry are not capable of controlling in the low consistency ranges required for cleaning systems. Dilution to consistencies of 1% or less is necessary for extracting the maximum amount of foreign material from the filler stock. After the stock has been diluted and passed through the cleaning system, it is necessary to thicken or increase the stock consistency to a point where it can be handled in a refining-type machine. The water extracted in the thickening process is then returned to a chest and recirculated back to the pulping and cleaning equipment as make-up and dilution water. This water extracted from the stock in the thickening process can provide a means of stabilizing and controlling the flow of white water to the pulping and cleaning system, thereby controlling the consistency of the stock being handled.

Figure 1 shows a modern pulping and cleaning system distribution of white water. The white water chests supplies the Hydrapulper, junk remover, and regulating box. Figure 2 shows the white water from the thickeners channeled into one pipe and flowing to a weir box where the actual quantity is measured and recorded. The quantity of water extracted by the thickeners is related to the number of gallons of stock delivered to the thickeners and to the consistency of this stock.

To utilize the return white water flow as a means of control, it is necessary to deliver a constant volume of stock to the cleaning system. This is accomplished in a regulating box. The stock from the pulper flows by gravity to the regulating box. The level in the regulating box is held constant by a liquid level controller operating a V-notched throttling valve. The throttling valve is located between the pulper and the regulating box. The regulated level in the box maintains a constant head on the suction of the pump delivering stock to the cleaning system. White water is introduced into the suction of the pump in accordance with the variation of level in the weir box. This results in a suction of constant head and constant consistency. A regulated suction condition allows the pump to deliver a constant volume at a regulated consistency.

The system functions as follows: the white water from the thickeners is collected and allowed to flow into the weir box B-1. The volume of white water returned is measured by a pneumatic recording and controlling instrument LL-1. The white water flows from the weir box to a two-section white water chest CH-1. This chest design allows preferential treatment of the white water used for dilution purposes. The overflow side of the chest discharges white water through pump P-1 to the junk remover and the Hydrapulper. The section of the chest receiving white water from the weir box utilizes the overflow to provide a constant inlet head on pump P-2. Pump P-2 furnishes dilution water to the Hydrapulper headbox. With constant suction conditions, pump P-2 is capable of delivering a constant flow.

As the level in the weir box varies, the controlled dilution valve V-1 introduces more or less water into the suction of the pulper dump pump. This tends to hold the weir box level constant, resulting in a constant discharge rate from the pulper dump pump to the Hydrafuge separator. A constant level in the weir box indicates a stock of constant consistency flowing to the thickeners. The liquid level controller LL-2 regulating the level in the regulating box B-2 also controls the make-up water to the Hydrapulper. Should the level in the regulating box tend to rise, the valve V-2 between the pulper and regulating box would automatically throttle the flow. This would cause the make-up water valve V-3 to throttle and maintain the level in the pulper. A decrease in level would cause a reverse action. If the level in the regulating box should rise high enough to close valves V-2 and V-3 the valve V-4 in the return white water line to the Hydrapulper would close also.

The pulper is charged at a rate consistent with the machine requirements. The amount of water that should be extracted by the thickeners, for the machine requirements, can be determined by any of the available charts or slide rules and measured to obtain the desired consistency. The overflow gate of the Classifiner headbox is equipped with a pneumatic operator and position controller. The position of the gate can be remotely controlled from the operator's control station. The operator's control station LC-1 incorporates a position indicator to assist the operator in the correct selection of tonnage delivered to the thickeners.

The weir box controller LL-1 is set for the number of gallons required for a certain tonnage and consistency. The headbox overflow gate is positioned to allow the correct tonnage to flow to the Classifiners. The level in the regulating box is adjusted at controller LL-2. After the level in the regulating box is determined, no further adjustment of this control should be required. This reduces the number of controls to be adjusted to two. The adjustment of these two controls regulates the consistency of the stock and the tonnage delivered.

WATER CONTROL IN BATCH SYSTEMS

Another problem in beater room operation is the measurement of make-up and wash-down water for batch operation. This can best be accomplished by automatic means. There are three methods of control that have been used quite extensively. Two methods require facilities for storing the measured water, while the third requires only the normal storage facilities.

The method shown in Fig. 3 requires a liquid level controller, three solenoid operated water valves, and a storage tank. Liquid level controller LL-2 is of the air purge type. A second level controller LL-1 is shown as an air purge type, however, it may be of the probe type. Controller LL-2 is equipped with two indices for automatic control. One valve is required for make-up water and one valve for shower or wash-down water. The third valve is required for automatically filling the tank.

The method of operation is as follows: when the storage tank is empty, both valves V-2 and V-3 are closed. The inlet valve V-1 will open and allow the storage tank to fill. When the tank is full the inlet valve automatically closes. When

J. H. Pearson, Electrical Engineer, The Black-Clawson Co., Shartle Brothers Machine Co., Middletown, Ohio.

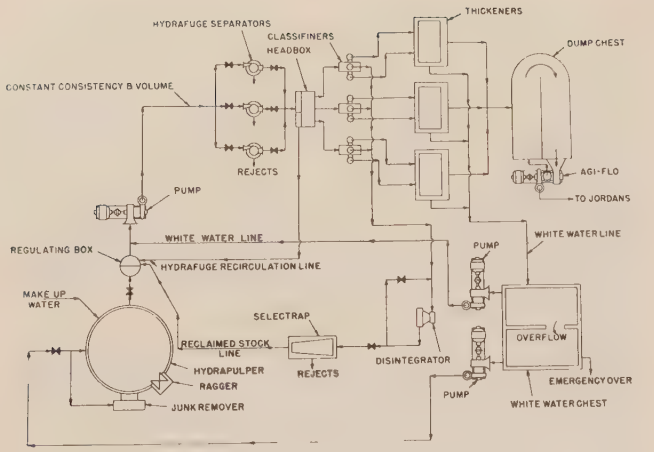


Fig. 1

water is required for the pulper, valve V-2 is opened. Water flows into the pulper until the level in the water tank drops to a point equivalent to the volume required, when valve V-2 will automatically close. Valve V-1 will open and the tank will fill to the level indicated by controller LL-1. When the pulping cycle is over, valve V-3 is opened and wash-down water is added to the pulper. Again, when the correct amount of water is added valve V-3 will close, and V-1 will open and fill the tank for the next operation. The amount of water added through V-2 and V-3 should be correct for the final consistency of the stock.

Some systems require hot water for pulping. This can be accomplished by adding a temperature controller LL-3 and a steam throttling valve V-4. The system can be interlocked so that water cannot be discharged until it is up to temperature. The system should also be interlocked to close the steam valve while water is being discharged to the pulper.

The second method is shown in Fig. 4. This system is somewhat similar to that previously described, except that it is not variable and is arranged for predetermined amounts of water. The system can include a switch for manual-automatic operation to offset the nonvariable features. The valves shown on this system are solenoid operated slide valves. This system utilizes probe type controllers and level indication is by pilot lights.

The Hydrapulper tank mounts two probe-type controllers LL-1 and LL-2. Valves V-1 and V-6 are interlocked to prevent valve V-2 from opening while water is being delivered to the Hydrapulper. The circuit is so arranged to give the Hydrapulper tank preference in the distribution of white water. The probes of the level controllers are cut to lengths proportional to the number of gallons required. When make-up water is required, valve V-1 is opened by push button control and water flows into the Hydrapulper, emptying the tank. Valve V-1 is then closed. This causes valve V-2 to open and

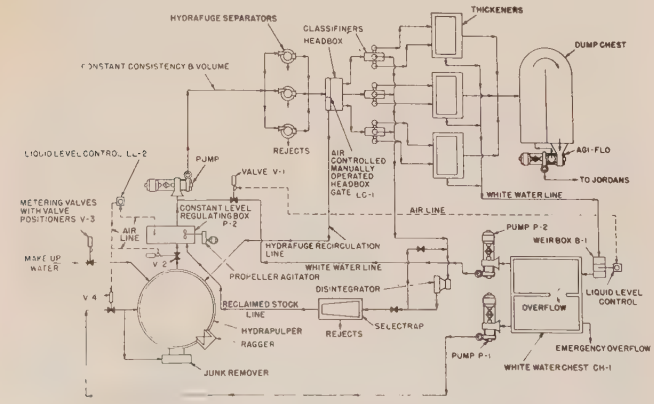


Fig. 2

fill the tank to the level controlled by the probe of LL-1. When shower water is required, valve V-6 is opened by push button control, and water will flow through the shower. When the water level drops below the probe of controller LL-2, the circuit breaks and valve V-6 will automatically close. Valve V-2 automatically opens and fills the tank until the level reaches the probe of controller LL-1, then valve V-2 automatically closes.

This system can also be extended as shown in Fig. 4 to include another tank for chest dilution. This tank is equipped with a probe-type liquid level controller LL-5 to automatically close valve V-3 when the tank becomes full. When dilution is required, valves V-4 or V-5 are opened manually by push button control. The level in the cycling chest is raised to a level indicating the correct consistency. When the correct level in the cycling chest has been reached, valves V-4 or V-5 are closed by the high level contacts of the indicating liquid level controller LL-4 or LL-5.

The third method of automatically measuring the quantity of water to a batch Hydrapulper is by use of a water meter equipped with automatic controls. The water meter is equipped with a transmitter that gives an electrical impulse equivalent to a certain number of gallons passing through the meter. The transmitter is connected to an impulse counter that can

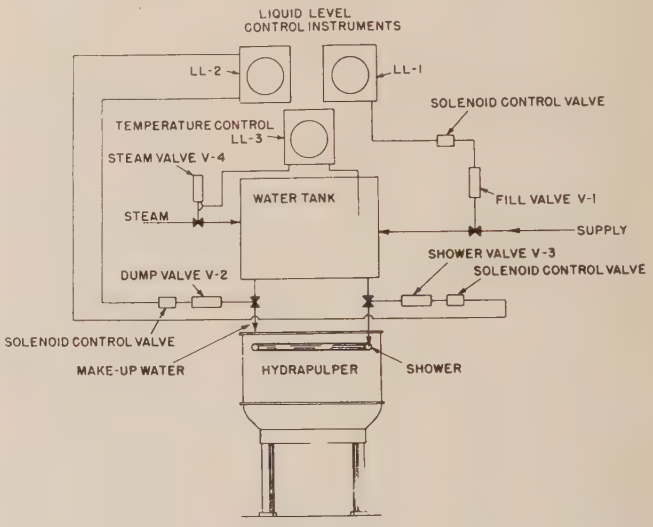


Fig. 3

be preset for the amount of flow required. When the supply started, the impulse counter is energized. When the correct number of gallons have been counted, the impulse counter will count out and open the circuit, stopping the pump, closing a valve, or both.

STOCK CAPACITY CONTROL AT JORDAN HEADBOX

Another application for a throttling valve in a stock preparation system is at the jordan headbox. Standard headbox design incorporates an overflow for by-passing a portion of the stock back to the chest from which it was pumped. This is done so that a constant head of stock is available at the suction of the jordan. This method of providing a constant head at the jordan suction normally requires a very large box so that overflow channels may be provided for each type of stock being handled. It is normal procedure to overflow approximately 25% of the stock pumped from the chest to the headbox. This requires greater pumping capacity; in some cases a larger pump, and in all cases more power. If the distance between the dump chest and the jordan headbox is great, the power required to pump this additional 25% of stock can be costly.

The method shown in Fig. 5 incorporates a single channel for each stock. Each channel feeds the number of jordans

required for each stock. The level in the channel is measured and controlled with a proportional-type liquid level controller using the air purge system of measurement. The output air of the instrument is directed to a throttling valve equipped with a valve positioner. This valve varies with the level in the headbox. A level controller and throttling valve are required for each type of stock being jordaned.

The liquid level instrument can be mounted at the operating floor. A means of remotely controlling the gates feeding the jordans can be arranged. This allows the operator complete control of the jordans from floor level.

STOCK CAPACITY CONTROL FOR MACHINE HEADBOX

Another application for a throttling valve is shown in Fig. 6. In conventional mill operation, the jordans and the machine are fed by headboxes equipped with overflow lines. Stock is overflowed to provide a constant head on the orifices of the headbox. This illustration shows a method of eliminating the overflow line from the machine headbox.

The jordan is fed by a loop system with a hand-operated throttling valve in the return side of the loop. This assures the jordan of a constant supply of stock under varying conditions. It also eliminates the jordan headbox. The jordan discharges to the machine headbox through a throttling valve

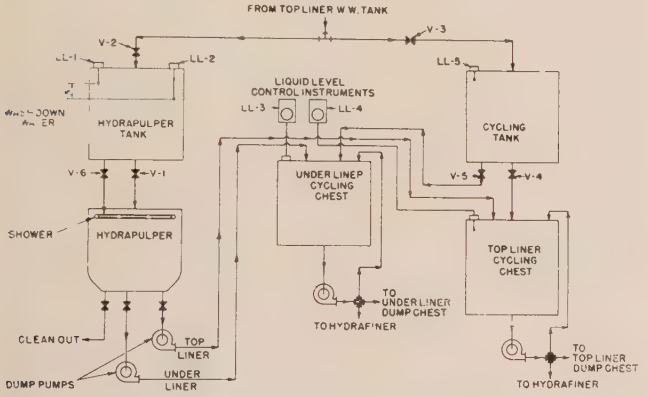


Fig. 4. Hydrapulper water system with probe control

equipped with a valve positioner. The level in the headbox is measured and controlled with a proportional-type liquid level controller using the air purge system of measurement. The output air of the instrument is directed to the throttling valve causing it to vary with the headbox level and in so doing, maintaining this level constant.

This arrangement provides the same control of the jordan and machine headbox as the conventional method. Since it is now possible for the machine headbox to accept stock directly from the jordan, the machine chest is not required.

SPECIAL HYDRAFINER CONTROL FOR DUO-CYCLING SYSTEM

Another method of automatic control is shown in Fig. 7. This flow diagram shows a thickener chest feeding two vertical chests which constitute a part of an automatic cycling system. The vertical chest in turn will feed four Hydrafiners operating in series in this particular system. The discharge of the Hydrafiners can be returned either to the cycling chests or to the dump chest. The entire system is controlled from a remotely located panelboard. The panelboard allows either manual or automatic operation of this equipment. The two vertical cycling chests are equipped with a liquid level control to indicate and control high level conditions. The Hydrafiners are equipped with automatic plug adjusting devices and their controls are also in the panelboard.

The automatic cycling system functions by taking stock

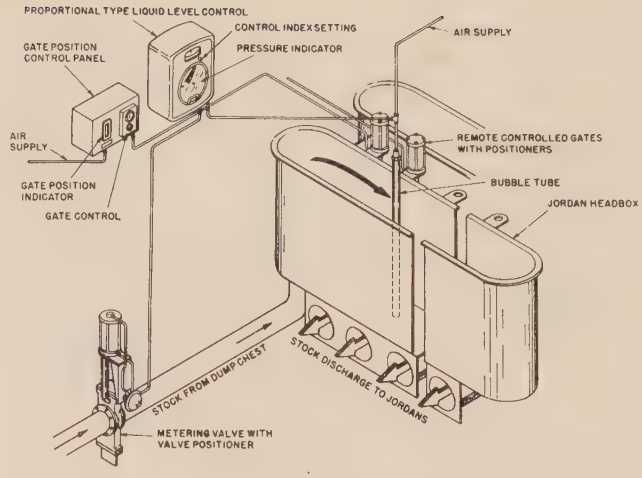


Fig. 5

from chest no. 1, discharging it through the Hydrafiners into no. 2 chest. When no. 1 chest is empty, the valves reposition themselves and the stock flows from no. 2 chest, through the Hydrafiners, back into no. 1 chest. This process will continue for a predetermined number of times. The number of times that the stock will pass through the Hydrafiners is preset from the panelboard.

A manual-automatic switch is supplied on the panelboard for the desired method of control. The initial start-up requires starting the cycling chest dump pump and the Hydrafiners. The Hydrafiners load adjusting rheostats are then preset for the desired motor load. The system is then switched to automatic. With the chests empty, no. 3 fill valve is opened and this in turn will cause valve V-5 to open and start pump P-1. Chest no. 1 will then fill to a predetermined level. When the level is reached, valve V-3 will close and in turn close valve V-5 and stop pump P-1. After this filling process is over, valve V-1 will open and valve V-6 will position itself so that the flow will go to chest no. 2. When chest no. 1 is empty, valve V-1 will close and V-2 will open. Valve V-6 will then position itself so that the stock will flow into chest no. 1. This process continues until the stock in one of the cycling chests has one or more passes to make through the Hydrafiners. Just prior to the start of the last pass, valve V-6 will position itself so that the stock will flow into the dump chest. While the stock is making the last pass through the Hydrafiners and being discharged to the dump chest, the empty cycling chest will be filling through valve no. 3 or 4, depending upon which chest is empty.

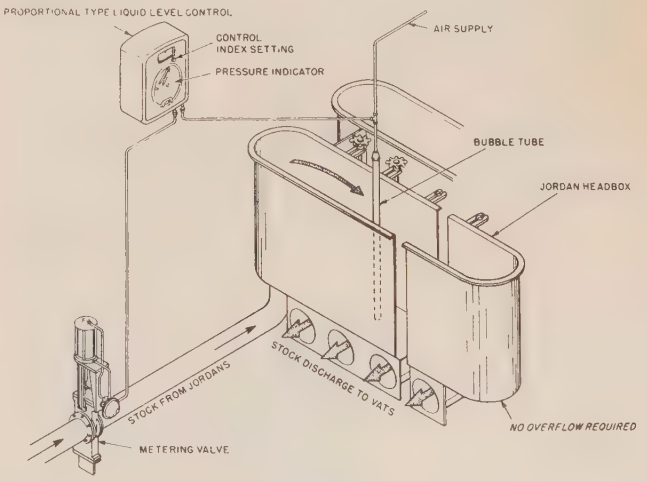


Fig. 6

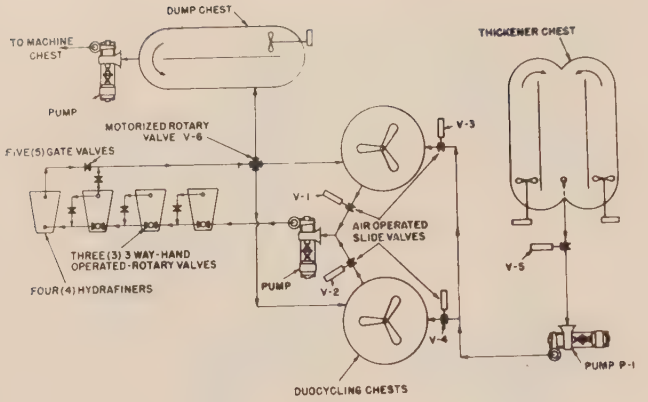


Fig. 7

After the cycling system has discharged the last of the stock through the Hydrafiners, the new batch just brought into the cycling system will start through for its required number of passes through the Hydrafiners. In the event the dump chest is full and cannot accept the stock from the cycling system, the stock will remain in either chest no. 1 or chest no. 2, the plugs will back out on the Hydrafiners and the dump pump will stop until such time that there is room in the dump chest for the stock. At this time, the stock will start to flow from the cycling chest to the Hydrafiners, the plugs will advance to the predetermined load and the system will continue as outlined above.

This system has many advantages: (1) it assures that all stock passes through the Hydrafiners for a predetermined number of passes and the stock will receive uniform treatment since the power input to the Hydrafiner is automatically controlled, (2) a minimum amount of man power is required for the operation of this system, (3) it bridges the gap between a continuous and batch system, and (4) it minimizes the human element in the papermaking process.

SUCTION COUCH CONTROL OF JORDANS

The final treatment of the fiber takes place in the jordan. Control of fiber length and freeness is accomplished in this unit. The relation of fiber length and freeness in various combinations results in variations of sheet formation and physical strength. These variations in freeness and fiber length also result in variations of the suction couch vacuum level. From this it would seem desirable to maintain a relatively constant vacuum level at the couch. A constant vacuum level at the suction presupposes uniform fibers coming from the jordan. Since this is not possible due to variations in the stock itself, some method of varying the jordan plug and shell relation is necessary to compensate for variations in stock treatment.

Suction couch vacuum control, as shown in Fig. 8, of the Duotrol electrical system, is a method by which a change in vacuum at the suction couch is interpreted as a function of change in the fiber conditions, fiber length and freeness of the stock passing over the fourdrinier wire. These changes in conditions produce proportional changes in the vacuum developed at the couch. The differential change in vacuum within predetermined limits is utilized to control jordan load settings on the Duotrol panel.

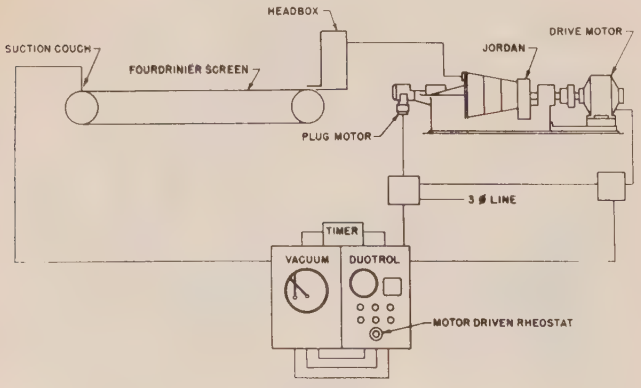


Fig. 8

The Duotrol is a device for automatically controlling the jordan load once this load has been preset. The selection of the load is accomplished by the setting of a rheostat. Once the load has been set, the Duotrol will hold the load to a very close tolerance. An indicating and controlling vacuum gage is used in conjunction with the Duotrol control panel to register vacuum measurement at either extreme of the preset vacuum differential. A circuit is completed to the rheostat drive motor in the Duotrol panel. The motor drives the rheostat to a jordan load setting which will maintain the desired vacuum reading, indicating constant conditions at the suction couch.

The Duotrol control panel consists of conventional Duotrol components with modifications and additions. A motor is used in the panel to drive the jordan load adjusting rheostat. Motor direction is controlled automatically by electrical circuits on the vacuum gage connected to the suction couch. A four-position selector switch enables the operator to select any of the three methods of operation: (1) vacuum control with Duotrol, (2) Duotrol alone, or (3) push button operation for controlling the jordan plug position. The fourth position on the selector switch is for automatic back-out of the jordan plug. Time delay circuits are employed to limit the movement of the load adjusting rheostat. Another circuit provides time delay for the corrected stock to reach the suction couch. If this correction does not restore the vacuum gage to its preset level, the system will again function to change the jordan setting and restore balanced conditions at the suction couch.

While this system shows a method of control for fourdrinier-type machines jordaning directly to the machine headbox, it could also be arranged on a machine where the jordaned stock is discharged to a chest and then pumped to the machine. An arrangement of this type presupposes a considerable time delay before the stock has stabilized itself to the point where it will provide a constant couch vacuum. This time delay, however, should not be a factor to rule out completely a system of this type.

Received Jan. 22, 1953. Presented at the 38th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 16–19, 1953.

Care and Maintenance of Rubber-Covered Rolls

E. L. LOCKMAN

The fact that the subject of the care and maintenance of rubber-covered rolls does not have the glamor or the attention attracting appeal that discussions of new products or new processes possess, does not in any way diminish its importance, as we are dealing here with the problem of obtaining the maximum operating performance from items which in themselves, while expensive, are also vital to the continued and efficient operation of machines representing large investments.

The following rules, while simple and based on common knowledge known to us all, should be constantly brought to the attention of all concerned. They may also be incorporated in any training program for new employees or refresher talks or discussions with old employees if such meetings are part of a mill's maintenance or training program.

E. L. Lockman, Manager, Tank Lining and Roll Covering Sales Dept., United States Rubber Co. Providence, R. I.

CASE OF RUBBER-COVERED ROLLS

1. In the case of crude rubber covers, particularly, do not allow grease or oil of any type to collect on the rubber covering. These materials will be absorbed by the rubber compound and cause it to swell, disintegrate, and lose its physical properties. In the event that any such materials do come in contact with the rubber, they should be removed promptly.

2. Do not allow rolls to be exposed to extremes of temperatures. Keep in a cool, dark, moist place, preferably in the shipping box.

3. Rubber-covered rolls, in or out of the machine, should always be supported on the journals. Never allow such a roll to rest on the rubber covering. In a relatively short time, the rubber will take a permanent set, out of round; synthetics more so.

4. If rolls are transported on hand trucks, journals should be blocked at sufficient height to prevent roll cover from coming in contact with the truck floor.

MAINTENANCE OF RUBBER-COVERED ROLLS

General

1. Do not allow rolls to remain out of use over long periods. When standing idle the outer surface of the roll cover tends to oxidize and this hard skin will crack causing checking if the roll is placed back in service without grinding. If continued in service in such condition, the roll covering may be seriously damaged. Therefore, any roll which has been out of service for a considerable period should be reground before being returned to the machine.

2. Rolls should be ground frequently. A roll run after it is worn out or corrugated will not give maximum service.

3. Be sure the loading is identical for both ends of any roll.

4. In removing rolls from the machine, use an overhead crane and wooden plugs against the roll shoulders to keep the sling from touching the rubber. Protect the journals where the sling is attached to prevent cutting or gouging.

Grinding Rubber-Covered Rolls

The type of wheel and the speed to be used for grinding any given rubber-covered roll will vary with mill practice, the type of grinding equipment available, and the density and the type of the roll itself.

Therefore, the following recommendations are necessarily general in nature and are based upon our own experience in the grinding of new rolls at our Providence factory.

Working with A. P. DiSanno and Son, we have developed a special resin bonded grinding wheel which has given us the best results of the many types tested to date.

Maximum speed, 1500 rpm
Feed
  Soft stocks
    Finish cut, slow speed, 4 i.p.m.
    Grinding, medium speed, 10 i.p.m.
    Polish, full speed of grinder, no. 100–150 emery cloth
  Hard stocks
    Grinder speed, all cuts, 10 i.p.m.
Spindle speed, 22 to 30 r.p.m.

Editing Orders for Recovering Rolls

Maintenance concerns not only the things we do from day to day to keep our equipment operating, but also the actions which we must take to reduce to a minimum shutdown time resulting from worn-out or damaged items of equipment.

In the case of a rubber-covered roll which has been damaged or has become worn to the point where it needs regrinding, we do have a somewhat special situation in that if a spare is not immediately available, in many instances the machine can continue to produce after the roll has been removed, but invariably this means making concessions such as reducing the speed or making some compromise with the quality of the product, which makes it imperative that the roll be recovered and returned to the mill in the earliest possible time.

Even if a spare roll is available it is still of greatest importance that the original be recovered and returned to the mill just as promptly as is possible.

Therefore, any action on the part of the mill personnel and the rubber manufacturer which can speed up the recovering process is important and in this connection, the author would like to point out that if you, on your part, will take the time to make sure that your order definitely gives to the rubber manufacturer the information listed below, you certainly will be contributing materially to speeding up the entire process.

If your order is not clear, or information is lacking, the resulting correspondence or telephone calls required to clear up the discrepancies simply cause avoidable delays.

In addition, the roll when returned, will be exactly in accordance with your requirements and complete information certainly puts the rubber manufacturer in a position to return the roll to you in the least possible time.

1. *Type of Roll.* State the classification such as press, table, felt, etc., and specifically state any special service condition such as elevated temperature or high nip pressure.

2. *Dimension.* To completely dimension the roll, there are four values required, these are: (1) inches, length of face; (2) inches, core diameter; (3) inches, thickness of rubber cover; and (4) inches, finished diameter.

In addition to the face length, preferably stated in inches, a statement should be made of the variation from specified length which is permissible without obtaining your clearance if it develops that face length specified does not agree with actual face length of the roll when received at the rubber mill. If the ends are to be covered, advise if face length should include end rubber covering.

Theoretically, core diameter plus thickness of rubber cover should equal the finished diameter.

Particularly in the case of rolls which have been recovered previously, because of scoring or sandblasting of the core, quite frequently the actual core diameter does not agree with the core diameter stated on the order which is usually taken from past records. Therefore, the order should specify whether the rubber thickness or the finished diameter is to be the controlling factor.

3. *Crown.* It is preferable to specify the crown in thousandths of an inch on diameter.

4. *Density.* Roll covering stocks should be ordered by density based on a P & J Plastometer with a $^1/_8$-in. ball.

5. *End Covering.* Be sure to give a complete description as to whether this includes ends, hubs, or shafts.

6. *General.* If any special finish such as type of grind, ribs, grooving, or coloring is required, be sure and specify in detail.

Received Oct. 22, 1952. Presented at the Seventh Engineering Conference of the Technical Association of the Pulp and Paper Industry, Chicago, Ill., Oct. 13–16, 1952.

LETTERS TO THE EDITOR

Bausch & Lomb Glossmeter

To the Editor, *Tappi:*

I note with interest the letter on page 172A of the September, 1953, issue of *Tappi* in which Mr. Wright of the Bausch & Lomb Optical Co. asks about possible interest in the renewed manufacture of the Bausch & Lomb glossmeter.

As you know, I have been active in the gloss field for a number of years and participated in the writing of TAPPI Method T 480 m-51, *Specular Gloss of Paper at 75 Degrees.*

This method was written to fit as closely as feasible the optical features of the Bausch & Lomb glossmeter.

To my knowledge, two companies are presently manufacturing and selling 75° glossmeters purporting to meet the requirements of T 480 m-51, H. A. Gardner Laboratory of Bethesda, Md., and the Photovolt Corp. of 95 Madison Ave., New York City. I think I have had enough experience with the different glossmeters to say that both of these manufacturers and also the Bausch & Lomb Optical Co. have found it somewhat difficult to build two or more 75° glossmeters duplicating one another in their results. At least, one laboratory in the paper industry recently studied the glossmeter problem in some detail and can also testify that it is not easy to keep several supposedly identical 75° gloss instruments alike.

In my opinion, the major need is for standards of intermediate gloss. Ceramic wall tiles have been used for this purpose and are now sold as calibrated standards of 75° gloss by the Bureau of Standards and the Gardner Laboratory.

To summarize: (1) there are presently available commercial instruments to measure 75° gloss, and (2) at present, the major needs are for improved glossmeter designs, easier to adjust and keep in calibration than those now available, and wider use of carefully calibrated gloss standards.

Richard S. Hunter, *Director*
Hunter Associates Laboratory
Falls Church, Va.

To the Editor *Tappi:*

The receipt of a copy of Richard Hunter's letter of October 2 to you has led me to write you concerning our efforts to provide better standards of 75° specular gloss for use with TAPPI method T 480 m-51.

At an angle of incidence of 75°, flatness of the gross plane of the standard is quite important. Ceramic wall tiles are usually curved because (1) convex surfaces give a pleasing appearance to a wall and (2) some curvature is caused by warping which takes place in the firing process. To obtain reasonably flat tile for use at 60° incidence we have had the tile manufacturers make slightly concave bisque tile which when fired becomes nearly flat. Our procurement specification has stipulated that $4^1/_4$-in. square tiles to be acceptable must be flat to within ± 0.004 in. on a 3-in. span. This is about as good as the manufacturers can do without having to reject more tiles than we accept.

In conclusion I should point out that even with the aid of standards it is not possible to make accurate 75° specular gloss measurements unless the glossmeter meets the aperture requirements of the TAPPI method or the reflected light flux distributions of specimen and standard are nearly identical. Since it is generally not practical to meet the latter requirement, the most useful role of standards is to provide a practical test of the former. This may be done by reading the gloss of a series of standards having different reflected light flux distribution. If the instrument readings do not agree closely with those assigned to the standards, the glossmeter should be readjusted, preferably by the manufacturer.

H. K. Hammond III
Photometry & Colorimetry Section
National Bureau of Standards
Washington, D. C.

EMPLOYMENT SERVICE

Positions Wanted

E256-53. Technical Director, B.A. in chemistry, 16 years in paper converting and packaging field. Outstanding record in research and development. Experienced in research management, control, material and product development, production process and machine design, and plant engineering. Development and application of plastics, waxes, adhesive compositions and other materials in paper and paper product manufacturing. Designer of process equipment and automatic packaging machinery. Seeking more challenging opportunity with a progressive concern.

E257-53. Recently resigned from executive position due to excessive travel. Well grounded in paper industry operation through positions of chief chemist, development engineer. Designer and complete erection supervisor for many proven and accepted white water and waste water treatment systems. Experienced in all modern methods of clarification. Familiar with existing and contemplated State stream improvement regulations. Seeking position in paper industry as coordinator of water treatment plans, design of plant and/or management of treatment plants and personnel. Married, age 41, 20 years' association with the paper industry. Interest in sales connection only on executive level.

Positions Open

P323-53. Quality Control Supervisor. To supervise installation of quality control program in Midwestern corrugated box and folding carton plant. Prefer man experienced in both quality control and production.

PULP AND PAPER SPECIALIST

Excellent opportunity in Technical Service Department of large well known producer of industrial chemicals. Central New York location.

Position requires an engineering degree and at least three years' experience in the pulp and paper industry. Age preferably not over 35 years. Salary commensurate with education and experience in chemical wood pulping and bleaching.

Give complete résumé in first letter. Address letters to **TAPPI P325-53, Technical Association of the Pulp and Paper Industry, 155 E. 44th Street, New York 17, N. Y.**

PAPER CHEMICALS SALESMEN

Several positions with good advancement potential available in large national chemical manufacturing organization, involving sale and service of chemicals to the paper manufacturers. Graduate chemists or chemical engineers, age 25 – 30 preferred, but not essential. Several years' technical experience in paper industry required. Please submit complete résumé and indicate salary desired. Our sales staff has been informed. Write to TAPPI, P329-53. Technical Association of the Pulp and Paper Industry, 155 E. 44th Street, New York 17, N. Y.

P338-53. Graduate Chemical Engineer, capable of organizing and supervising control of quality and operations in bleached sulphite mill in Eastern Canada. Large expansion program planned.

P342-53. Chemist, B.S. Opportunity in packaging division of food company laboratory located in New York City. One year's experience in packaging desirable. Salary open. State age, experience, education, and salary expected.

P343-53. Two college-trained men for equipment design and the test operation of basically new wood utilization plant. First project minimum 1 year, excellent prospects later development work and expansion. Unique opportunity for younger man to learn active new field in association with internationally known engineers. On large lake in resort area. Top salary.

Note: Responses to the above inquiries should be sent to TAPPI, 155 E. 44th St., New York 17, N. Y.

PAPER CHEMIST

Technical service man wanted by large producer of industrial chemicals; metropolitan New York City location; Degree in chemistry or engineering required, with 3 years' industrial experience. Send complete résumé. Write Box TA-1939, 221 W. 41st Street, New York, N. Y.

HEMICELLULOSE AND CELLULOSE

Pacific Section of the Technical Association of the Pulp and Paper Industry

THE following two papers are abstracts prepared by Dr. Louis E. Wise of The Institute of Paper Chemistry and Dr. Emil Heuser, formerly with that institution but now retired and residing in La Jolla, Calif., covering their remarks and the discussion at the Seventh Annual Seminar sponsored by the Pacific Section. The seminar, which this year was devoted to the chemistry of hemicelluloses and cellulose, was conducted at the University of Washington, Seattle, Wash., on the mornings of Sept. 23 and 24, and at the Multnomah Hotel, Portland, Ore., on the mornings of Sept. 28 and 29, 1953.

Dr. Wise and Dr. Heuser continued the series of outstanding reviews of subjects of special interest for qualified scientific men in the Pacific Coast pulp and paper industry. Prior seminars have been conducted by Dr. E. Heuser and Dr. H. Mark on "Cellulose," by Dr. H. Erdtman on "Lignin and Non-Carbohydrate Extractives in Wood," by Dr. J. A. van den Akker on "Optics in the Pulp and Paper Industry," by Dr. Borge Steenberg on "The Mechanical Properties of Paper" and last year by Dr. Karl Freudenberg on "Cellulose and Lignin."

Dr. Wise has served as a professor at the New York State College of Forestry, at Rollins College, and at present is Research Associate at The Institute of Paper Chemistry, Appleton, Wis. Dr. Heuser has served as a professor at the Universities of Darmstadt, Berlin, and at The Institute of Paper Chemistry, and as Director of Research of the Canadian International Paper Co.

The seminar was offered in two different cities at different times to provide geographic convenience, to keep the audience small enough for good discussion, and to make it possible for two separate groups of men from the same laboratory to attend the seminar at different times.

The Hemicelluloses

LOUIS E. WISE

IN THE first session, which was devoted to some of the more recent fundamental studies, the difficulty in differentiating sharply between wood cellulose on the one hand and to the hemicelluloses on the other, was alluded to. A clean-cut line of demarkation of these two carbohydrate systems is impossible, and there is an area which may be classed either with cellulose or the hemicelluloses, depending largely on the viewpoint of the investigator, and also on the techniques used in separating cellulose from the hemicelluloses (*1*). However, the following gross differentiations can be made: (1) the original wood cellulose has a much higher average degree of polymerization (D.P.) than have the isolated hemicelluloses; (2) the hemicelluloses are much more readily soluble in alkali and more readily hydrolyzed by dilute acids than is cellulose; (3) native cellulose is fibrous, whereas the hemicelluloses are nonfibrous; (4) cellulose, on hydrolysis, yields dominantly D-glucose whereas the hemicelluloses yield dominantly D-xylose; (5) cellulose has a higher ignition temperature than have the hemicelluloses (*2*).

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In the hemicelluloses from coniferous woods, the following sugar units are present (besides xylose): mannose, galactose, arabinose, and glucose (*3*). In those of the hardwoods, these same units (with the possible exception of mannose) may occur, together with rhamnose (*4*). These sugars have been identified in or isolated from the acid hydrolyzates of the hemicelluloses.

Another characteristic product of hemicellulose hydrolysis is an aldobiuronic acid, which, in the case of aspen and sprucewood, was shown to be 2-α-[4-*o*-methylglucoronosyl]-D-xylopyranose (*5*). This compound was first isolated (as the barium salt) by O'Dwyer (*6*). The techniques used in determining the configuration of this aldobiuronic acid (*5*) were discussed in some detail.

Acetyl groups in wood are also present in the hemicellulose system and evidence was presented that in the wood these are linked to xylose units (*5*, *7*). Naturally, the acetyl groups are lost when the hemicelluloses are removed and isolated by means of alkali.

Difficultly removable contaminants (like starch and pectic materials which may remain in hemicellulosic fractions) were also mentioned. Methods for isolating hemicelluloses directly from (extractive-free) wood, and from carefully prepared holocelluloses were outlined (*7*). Some of the larger fission products of hemicelluloses were described—especially the crystalline xylan fragment (D.P. ca. 39) isolated by Yundt (*8*), in which the vicinal xylose units in the chain appear to be linked through positions 1 and 4 (as in cellulose). How mannose, galactose, or glucose units are linked in the hemicelluloses remains unknown.

It was also pointed out that although various investigators have shown that the number average D.P. of hemicelluloses, both from hardwoods and softwoods is about 150 (*9–12*), these preparations were actually nonhomogeneous. In the case of spruce, the D.P. range was approximately 50 to 300 (*10*).

Hemicelluloses isolated from other fibrous raw materials (like the cereal straws) were alluded to very briefly. The so-called "lignin-carbohydrate complex"—which is still a controversial subject, was also discussed, and at some length. There is accumulating evidence that a compound between lignin and hemicelluloses may exist, but conclusive proof is still lacking (*13*).

Work done at The Institute of Paper Chemistry on an insoluble copper-complex formed and remaining insoluble when coniferous wood pulps are treated with cuprammonium hydroxide was described. When decopperized, this substance yields a polysaccharide giving largely mannose on hydrolysis (the principal other product being glucose) (*14*).

In the closing of the first seminar, the following possible avenues for future research were suggested:

1. Separation from each other, by less drastic means, of polysaccharides differing in configuration. This would include better means of separating the hemicelluloses and pectic material of wood. Such separations if accomplished satisfactorily should *precede* studies on the structure of the hemicelluloses.

2. Further studies on the configuration of hemicellulose fragments isolated from coniferous woods.

3. Methylation, and configurational studies on more carefully prepared wood holocelluloses.

4. Graded acid and enzymatic hydrolyses of hemicellulose fractions repeating, whenever possible, Yundt's crystallization techniques, striving whenever possible, to isolate and determine the structure of well-authenticated and reproducible fragments (e.g., O'Dwyer's oligosaccharide containing six xylose and one uronic acid units).

5. New approaches to the problem of the lignin-carbohydrate complex.

6. More fundamental studies bearing on the difficulty in cleaving the glycosidic linkage in aldobiuronic acids.

7. Further studies on the molecular magnitude of hemicelluloses, and chain length distribution studies of their acyl derivatives.

8. Continued studies on the so-called "skin substance" (i.e., material insoluble in cuprammonium hydroxide) obtained from sulphite and kraft pulps, as an acid in showing chemical differences.

In the second seminar attention was focused on the technological significance of the hemicelluloses. There was a brief discussion on the types of hemicelluloses that were retained in kraft (*15–17*) and in sulphite pulps, with emphasis on studies made in differentiating between these two pulp types, in each of which the distribution of the hemicelluloses within the cell wall appears to be quite different (*18*).

Some of the progress made in studying the hemicelluloses retained by semichemical pulps was also outlined (*19*).

Early in a kraft cook certain polysaccharides can be recovered from the black liquors—the most persistent carbohydrates being the pentosans, the hexosans probably being destroyed and converted into saccharinic acids (*21*). No simple sugars were isolated (*20*). In the case of the sulphite cook simple sugars enter the cooking liquor in the following sequence: arabinose, galactose, xylose [mannose + glucose] (*17*). The dominant sugar (from coniferous woods) is mannose (*22*). Modes of destruction of these sugars were outlined.

Recent work indicates that in semichemical (neutral) sulphite digestions, small amounts of hemicellulosic materials (little changed) can be recovered from the liquors (*19*). The dangers of hot water extraction of wood were emphasized; experimental data indicate that such pre-extraction causes degradation of the hemicelluloses of the cell wall.

Some time was given to the utilization of sugars in sulphite spent liquors, in the production of alcohol, baker's and *Torula* yeasts, lactic, acetic, and butyric acids, butanol, acetone, and isopropanol (*23*). The effects of these sugars in causing stream pollution were also mentioned and discussed by the audience.

There was considerable discussion on the effects of certain types of hemicelluloses on pulp strength, and in this area the work of Rowland and Young (*24*), March (*25*), Obermanns (*26*), Aiken (*27*), Jayme (*28*), Ratliff (*29*), and Schoettler (*30*) was reviewed. The significant effects which hemicelluloses have on pulp quality were emphasized.

It was shown that two pulps prepared by different methods from the same wood could retain identical amounts of alkali-soluble hemicelluloses and yet have markedly different properties. Similarly two pulps retaining almost identical amounts of pentosans showed a very different physical behavior (*25*). Schoettler's recent work on "alkali-resistant pentosans" in alpha-cellulose was reviewed, and the effects (on pentosan retention) of pretreatment of the wood, fineness of division and moisture content of the pulp, the concentration and type of alkali used were outlined (*30*).

From recent orienting experiments made by Thompson and Swanson (*3*) it appears that the *configuration* of the sugar units (and their amounts) may have an important bearing on pulp quality. With due reservations it was suggested that mannose units may be especially effective. Softwood hemicelluloses proved markedly superior, as beater additives, to those from aspen.

The harmful effects of residual hemicelluloses on dissolving pulps (used in producing cellulose acetate) were stressed. It was also pointed out that an excess of hemicelluloses might decrease the quality of paper pulps.

In closing the second seminar in this series the following topics for study were suggested:

1. A more complete study of the fate of polysaccharides entering kraft black liquors; a study of the resulting saccharinic acids.

2. Further studies on the polysaccharides in the spent liquors of semichemical pulping operations.

3. A more thorough investigation of the nature of hemicelluloses remaining in semichemial pulps.

4. The effect of mechanical pulping on hemicelluloses.

5. An effort to determine which are the most desirable groups in hemicelluloses remaining in kraft and in sulphite pulps.

6. Retention studies of hemicellulose fractions used as beater additives, with a view toward determining what role is played by configuration of the sugar units in such hemicelluloses (e.g., mannose units).

7. The fate of hemicelluloses during pulp bleaching operations.

8. Further studies correlating the amount and/or type of hemicelluloses with the properties of hardwood versus softwood pulps.

9. Further chemical studies on the constitution of hardwood and softwood alpha-celluloses prepared under reproducible conditions.

LITERATURE CITED

1. Wise, L. E., in Wise and Jahn's "Wood Chemistry," New York, 1952, pp. 385–388.
2. Buchanan, M. A., *Tappi* 35: 209 (1952).
3. Thompson, J. O., Swanson, J. W., and Wise, L. E., *Tappi* 36: (1953).
4. Jones, J. K. N., and Schoettler, J. R., *Tappi* 35: 102A (1952).
5. Jones, J. K. N., and Wise, L. E., *J. Chem. Soc.* 1952: 2750 and 3598.
6. O'Dwyer, M. H., *Biochem J.* 33: 7-B (139); 34: 149 (1940).
7. Wise, L. E., and Ratliff, E. K., *Ind. Eng. Chem., Anal. Ed.* 19: 459 (1947).
8. Yundt, A. P., *Tappi* 34: 89, 91-95 (1951).
9. Husemann, E., *J. Prakt. Chem.* 155: 13 (1940).
10. Wethern, J. D., *Tappi* 35: 267 (1952).
11. Thompson, J. O., and Wise, L. E., *Tappi* 35: 331 (1952).
12. Timell, T. E., and Jahn, E. C., *Svensk Papperstidn.* 54: 831 (1951).
13. Harris, E. E., *Tappi* 36: 402 (1953).
14. Rollinson, R. R., and Wise, L. E., *Tappi* 35: 139A (Nov., 1952).
15. Wise, L. E., and Rittenhouse, R. C., *Tappi* 32: 397 (1949).
16. Wise, L. E., Rittenhouse, R. C., and Garcia, C., *Tappi* 34: 15 (1951).
17. Sundman, J., Saarnio, J., and Gustafsson, C., *Paper and Timber* (*Finland*) 33: 115 (1951).
18. Jayme, G., and von Köppen, A., *Das Papier* 4: 373, 415, 455 (1950).
19. Lea, David, Doctoral Dissertation, The Institute of Paper Chemistry, June, 1953.
20. Saarnio, J., and Gustafsson, C., *Paper and Timber* (*Finland*) 35: 65 (1953).
21. Klason, P., and Segerfelt, B., *Arkiv. Kemi Mineral. Geol.* 4: No. 6: 1 (1911).
22. Boggs, L. A., Private communication.
23. Harris, E. E., in Wise and Jahn's "Wood Chemistry," 1952, pp. 915–929.
24. Young, G. H., and Rowland, B. W., *Paper Trade J.* 97: No. 15: 44 (Oct. 13, 1933).
25. March, R. E., *Tech. Assoc. Papers* 31: 240 (1948).
26. Obermanns, H., *Tech. Assoc. Papers* 20: 429 (1935).
27. Aiken, W. H., *Ind. Eng. Chem.* 35: 1206 (1943).
28. Jayme, G., *et al., Papierfabr.* 38: 45 (1940); *Holz, Roh u. Werkstoff* 3: 2 (1940); 5: 10, 377 (1942); *Die Chemie* 55, No. 43/44: 323 (1942); *Cellulosechem.* 21: 19, 73 (1943); *Papierfabr. Wochbl. Papier fabr.* No. 7: 223 (1943).
29. Ratliff, F. T., *Tappi* 32: 357 (1949).
30. Schoettler, J. R., Doctoral Dissertation, Institute of Paper Chemistry, (1952).

Cellulose

EMIL HEUSER

In view of the essential role which the morphological structure plays in the processes of isolating the fibrous cellulose from its lignified raw material, as well as in the course of subsequent cellulose reactions, more time was devoted to this subject than to the actual chemistry of cellulose, and, thus, the morphological structure of the cellulose fiber was the first subject to be taken up.

The morphology was dealt with as comprising both the microscopic structure, as it may be recognized with the aid of a light microscope, and the fine or supermolecular structure, as first, only indirectly and purely abstractly, deduced from the x-ray diffraction pattern, but now to a considerable extent, documented more directly in the electronmicrograph.

Since our knowledge on the subject of fiber morphology has been advanced to a higher degree in regard to the cotton fiber than to the wood fiber, it was thought helpful first to review the essential findings concerning the morphological structure of the cotton fiber and then to see what has become known with regard to the wood fiber.

In recent years, much progress has been made on the nature and the behavior of the outer layers, that is, the primary cell wall and the winding layer, the latter being located immediately beneath the primate wall, as well as on the lumen.

Much of the work discussed was taken from publications by Mary Rollins and co-workers in the Cotton Fiber Division of the Regional Southern Research Laboratory in New Orleans The presentation was illustrated by a variety of reproductions and by numerous lantern slides, the latter having kindly been lent by Miss Rollins.

The review of these recent studies would seem to confirm the view that it is the primary wall and the winding and probably also the lumen which, in the cotton fiber, act as protective membranes and which block the easy access of reagents to the cellulose proper in the secondary cell wall.

Turning to the wood fiber it was pointed out that here morphological studies encounter more difficulties. Whereas the cotton fiber grows as a single biological cell of relatively large dimensions and essentially free of heavy incrustations, the wood fiber cell is much shorter and grows in close association with a number of other cells, these associations being heavily incrusted with lignin. Thus, the structure of the individual wood fiber is less accessible to investigation. In addition, it was pointed out, that the interpretation of the light-microscopic and electronmicroscopic observations, particularly when the results from different countries are compared, would seem to vary with the investigator—a situation which ought to be remedied. In other words, what is needed is (1) a more uniform and unequivocal terminology and (2) a more uniform interpretation. An approach to this goal might be facilitated if the terms and concepts as developed for the cotton fiber, both of which are internationally more uniform and unequivocal, were used as a guide.

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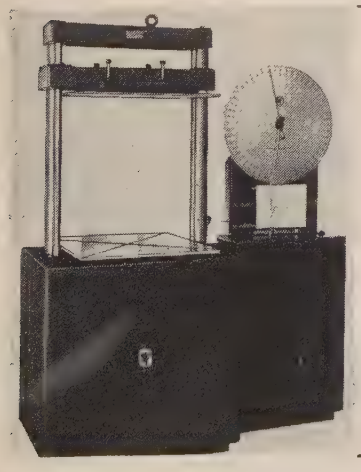
This was done in the Seminars, when the morphology of the wood fiber was discussed. The presentation of the microscopic structure was illustrated by numerous reproductions from the "Morphology and Structure of Wood Fibers" by Hans Bucher and Louis P. Wiederkehr-Scherb, published in 1948 by Cellulosefabrick Attisholz in Solothurn, Switzerland. In addition, reproductions from the publications of Haas (Waldhof Pulp Corp.) and of R. L. Mitchell and some lantern slides, kindly lent by Mr. Goldschmid of the Rayonier Corp., were used for illustration.

It was shown that similarly to the cotton fiber, the primary wall and other thin membranes of the wood cellulose fiber may be regarded as morphological obstructions and how their partial or full elimination leads to an increase of the reactivity of the fiber. In this connection, the differences in behavior of these membranes toward acid and alkaline pulping procedures were pointed out. Other subjects here discussed were concerned with the opening of the pulp fiber structure by swelling in water, aqueous alkalis, and other swelling agents and the retention of the open structures by solvent displacement techniques; furthermore the complete elimination of the gross-morphological structure by dissolving; the regeneration of fiberless cellulose and the effect of grinding cellulose fibers in an oscillating mill or mills of similar efficiency.

Turning to the fine structure of the cellulose fiber, it was pointed out that its duality, that is, consisting as it does, of crystalline and amorphous regions, places a further obstacle into the path of the reagents, but that alterations of the crystalline-to-amorphous ratio are reflected in changes in the reactivity of the cellulose.

The last obstruction to a smooth course of cellulose reactions is seen in the molecular structure of the cellulose chain proper, i.e., in the difference in reactivity of the primary as compared with the secondary hydroxyl groups. This was termed the "chemical reactivity," and attention was directed to the competition between the chemical and the physical reactivity of the fiber, and examples were given to show that either one may predominate.

As regards the molecular structure, it was pointed out that the straight-chain structure has in general withstood the attempts to modify it. Of the more recent suggestions, the pros and cons of the weak-linkages concept of S. V. Schulz were discussed, and short mention was made of van der Wyk's branched-chain postulate.



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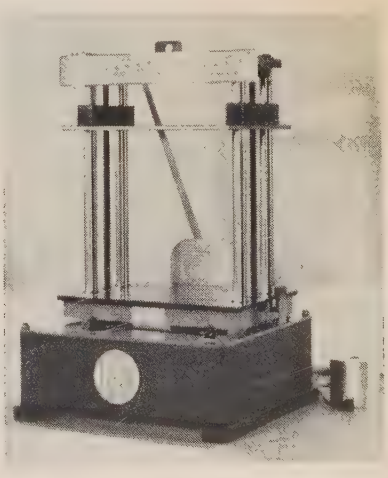

E. J. ALBERT AWARD PAPERS—1953

Delaware Valley Section, Philadelphia, Pa., May 28, 1953

The Canadian Standard Freeness Test Versus a Drainage Time Test for Highly Refined Stock

R. J. BECKER

Much has been written about the relative merits of a drainage test versus the Canadian Standard freeness test as a measure of stock refining, or as a test to evaluate and predict wet-end handling of a given stock prior to the time formation takes place on the wire.

Campbell and Lodge (*1*) stated that the Canadian Standard freeness test indicates the drainage characteristics of stock on the table roll portion of the paper machine, at least in the case of newsprint stocks. They maintain that disagreement between Canadian Standard freeness test values and mill experience fails after the sheet has formed and suction is applied at the suction boxes. Casey (*2*) contends that conditions used in measuring drainage factor on a British sheet mold came closer to conditions on the paper machine than those used in the freeness test because of the greater head of stock used in measuring drainage factor compared with that used in the freeness tester.

He goes on to say that the greater head of the British sheet mold contrasted against the freeness tester, compacts the pulp to a greater degree and therefore, more nearly approximates the condition which exists on the paper machine. In essence, these authors state that neither test yields a true measure of expected wire conditions but of the two, the drainage test is generally considered to more closely approximate machine conditions. However, the purpose of this paper is not to restate or elaborate on the theoretical considerations behind either test or their relation to the paper machine. This is an attempt to judge Canadian Standard freeness and drainage time as a measure of the high degree of refining found in the glassine, greaseproof, and condenser paper field. The stock in question, as it reaches the headbox, usually is in a Canadian Standard freeness range below 100 ml.

Figure 1 is a graph of drainage time and Canadian Standard freeness plotted versus refining time. The stock is 100% sulphite which has been refined by batch process with jordans. As the refining time increases and the stock approaches the desired degree of refining, the freeness change per unit time decreases while the drainage time per unit time increases. This increase in drainage time gives values of a much larger order of magnitude at the refining end point while the freeness test in contrast decreases in magnitude. Values as low as zero freeness have been recorded in the mill on certain grades. This is a practical example of the failure of the freeness tester for control testing of highly refined stock.

Even more misleading than a zero freeness test is the possibility of false freeness values. If stock has been so highly refined that the fines pass through the drainage plate of the freeness tester to the extent that they cause a false high initial flow, it is possible to get reverse freeness readings. Figure 2 is a curve of drainage time and freeness versus ball mill time in minutes. The pulp used here is 100% Ontario regular sulphite. At a ball mill time of 180 min. the freeness was at 55 ml. After an increase of 45 min. in the ball mill, the freeness rose from 55 to 86 ml. showing a breakdown of the freeness test. The drainage time in contrast continued being a valid test even with the additional ball mill time. These data indicate the possibility that during the continuous refining of stock through a battery of refiners with an end point of low freeness as a guide, stock could be refined beyond the desired true freeness to a corresponding false freeness. Since the drainage tests show no such breakdown with excessive refining, an error corresponding to false freeness would be impossible.

Because various pulp furnishes are used in the manufacture of glassine and related grades, the question arises whether drainage time will vary from furnish to furnish if freeness is kept relatively constant. Campbell (*1*) uses the example of groundwood at 82 ml. freeness as compared with beaten sulphite at a freeness of 315 ml. The sulphite had a drainage factor of 63 sec. per gram while the groundwood had a drainage factor of 36 sec. per gram. The drainage test here contradicts the freeness test. Figure 3 is similar data based on glassine pulp furnishes selected at approximately equal freeness levels. These stock samples were taken at the stuffbox during actual mill runs. Because drainage is a straight line function of sheet weight, curves were plotted for various handsheet weights against drainage time at constant temperature (20°C). At a sheet weight of 1 gram, 100% sulphate pulp shows a drainage time differing by approximately 100 sec. from 100% sulphite pulp. At a 2-gram sheet weight the sulphate pulp differs by 180 sec. from a sulphite pulp approximately at the same freeness. The third curve is that of 70% sulphite and 30% sulphate blend which tends to substantiate the data by falling into position between the two other curves. It is also reasonable to assume that be-

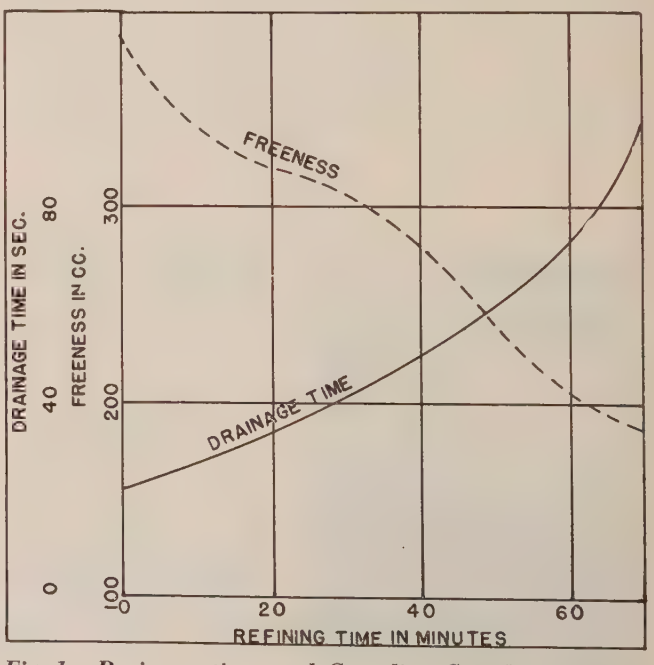

Fig. 1. Drainage time and Canadian Standard freeness versus refining time

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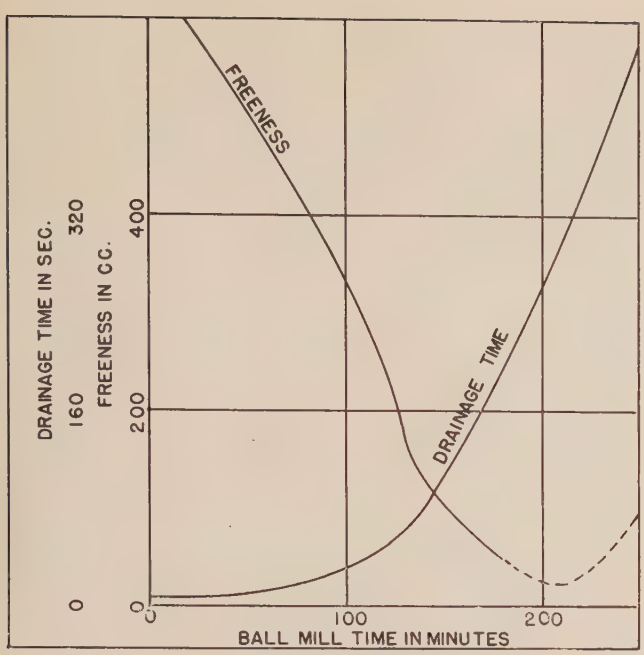

Fig. 2. Drainage time and Canadian Standard freeness versus ball mill time

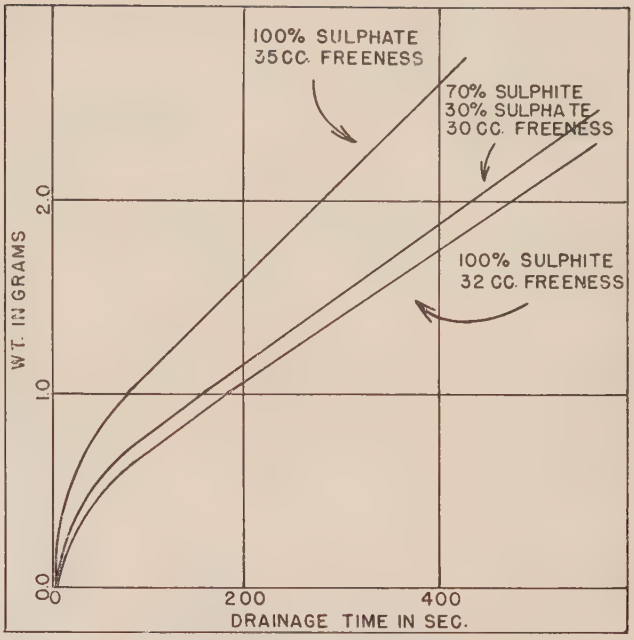

Fig. 3. Drainage time versus sheet weight

cause sulphate pulps differ from sulphite pulps in drainage time that sulphites and sulphates may differ among themselves to a lesser degree.

While there are consistency corrections for the freeness tester, it would be impractical to establish weight correction curves for every pulp or various combinations of pulp. Although the variation of weight to drainage time is a straight line, as shown in Fig. 3, the slope of the lines varies from pulp to pulp. This would necessitate consistency checks and accurate dilution so that the test would be performed at a constant addition of moisture-free pulp to the sheet mold.

In order to utilize the drainage time test as a control test, temperature corrections would have to be constant for different furnishes at similar drainage times. Reed and Davis (*3, 4*) state that drainage time is proportioned to the viscosity of the water in which the fibers are suspended. Figure 4 is a plot of temperature versus drainage time with the sheet weight constant for each pulp tested. There is a slight va-

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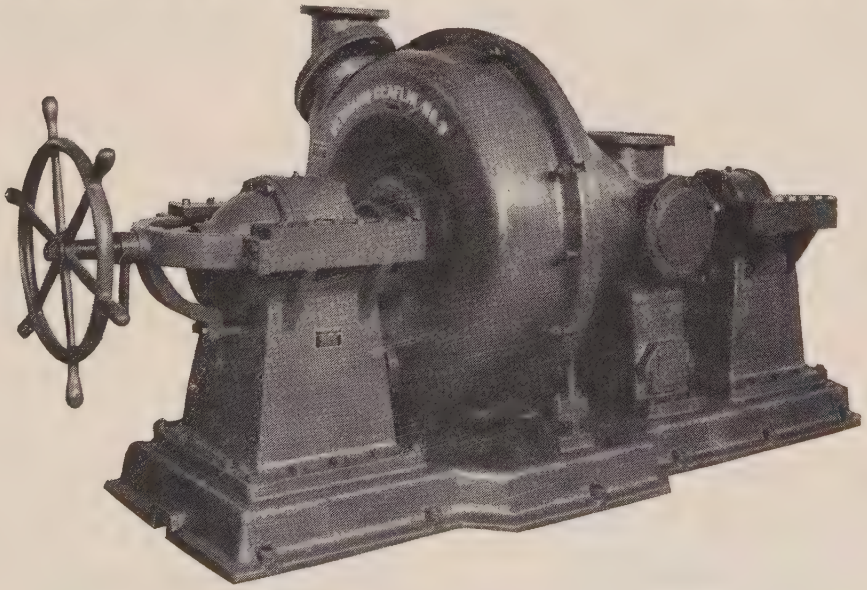

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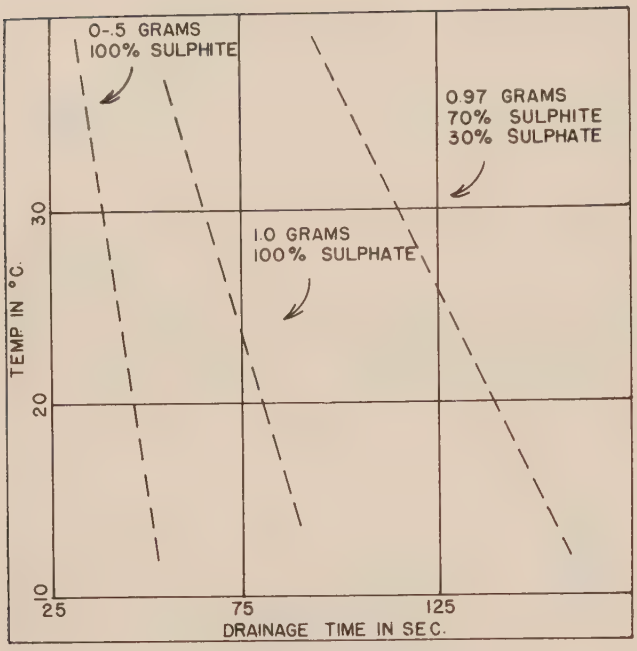

Fig. 4. Temperature versus drainage time

riation in slope between furnishes, but by calculation of the ratio of change in water viscosity over the same temperature range shown here, the points plotted fall within experimental error. These data show that even with a highly refined stock temperature corrections are constant for various pulps.

For mill control work drainage time tests like freeness can be performed by relatively unskilled personnel. Of the two, the drainage test may take a slightly longer period of time to perform. A drainage test will also demand the full attention of the tester as he watches for his end point while freeness requires no such attendance. Installation of a drainage test for control work would also necessitate some re-education in the thinking of mill production personnel.

The limited data presented here, along with material cited from the literature, indicate that for highly refined stock a drainage test may well yield more satisfactory and significant information than a Canadian Standard freeness value. Much more data on drainage time should be collected and interpreted. This paper is not an attempt to eliminate the freeness test as a valuable tool of the glassine papermaker, but rather to indicate its limitations.

LITERATURE CITED

1. Campbell, W. Boyd, and Lodge, W. C., *Pulp Paper Mag. Canada*, pages 189–200, Convention Issue 1937.
2. Casey, James P., "Pulp and Paper," pages 434, Interscience Publishers, 1952.
3. Reed, R. W., *Paper Trade J.* 114, No. 25: 291–297 (June, 1942).
4. Davis, D. S., *Paper Trade J.* 91, No. 21: 49–50 (Nov. 20, 1930).

A Nonstatistical Approach to Improving Wet-Strength Resin Evaluations

VINCENT J. MOSER

EVALUATING chemicals for paper is difficult because of the heterogeneous nature of paper. Tests employed in evaluations reflect this nature as experimental error and consequently leave considerable doubt as to how much better one chemical is than another for producing a given effect. This situation can be improved by what we believe is a novel approach.

Since the source of this uncertainty is the random errors in the application and testing, something must be done about these errors if the test is to be more meaningful. One obvious thing to do is make and average more tests to minimize the random errors. This, however, is time consuming and expensive, and really heavy handed. Sometimes knowledge of the relationships between the chemical treatment and its effect suggests an alternative to extensive testing. In general, our approach to the problem is to make the effect more dependent on the treatment and thus relatively less dependent on the experimental errors. In other words, it is to redesign the test so that in effect there are larger differences upon which to base a decision.

First let us demonstrate these alternatives schematically. In Fig. 1 the lower curve is a plot of some effect versus extent of treatment by some chemical. The height of the rectangle through which the line passes in some expression of the experimental error, and the width is an implication of that error. The width implies uncertainty of treatment, although the treatment itself is assumed to be exact. If more tests were run the height and consequently the width could be made smaller with the techniques of the statistician which need not be discussed here.

However, only the width is of real concern to us because it represents uncertainty in the amount of chemical needed for a given effect. The width of the rectangle would be decreased even if the height remained the same if the slope of the line were increased as in the upper curve of Fig. 1. In many practical cases the slope can be increased, namely, by making the effect more responsive to the treatment.

So much for the general problem. The particular effect with which we are concerned is wet strength in paper and the chemicals, wet-strength resins. The problem is to decide how much less of one resin than another is required to produce the desired wet strength. But how much less cannot easily be determined with the necessary precision. We found that we could determine how much less with greater precision by employing a semilogarithmic plot, which is a straight line plot, of wet strength against the amount of resin used, and then by increasing the slope of that line by using more highly beaten pulps which are more responsive to wet-strength resin treatment.

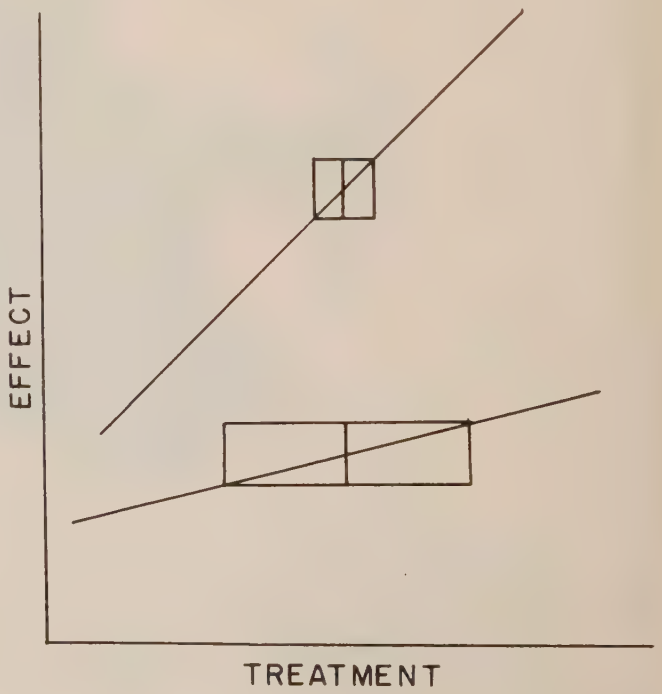

Fig. 1

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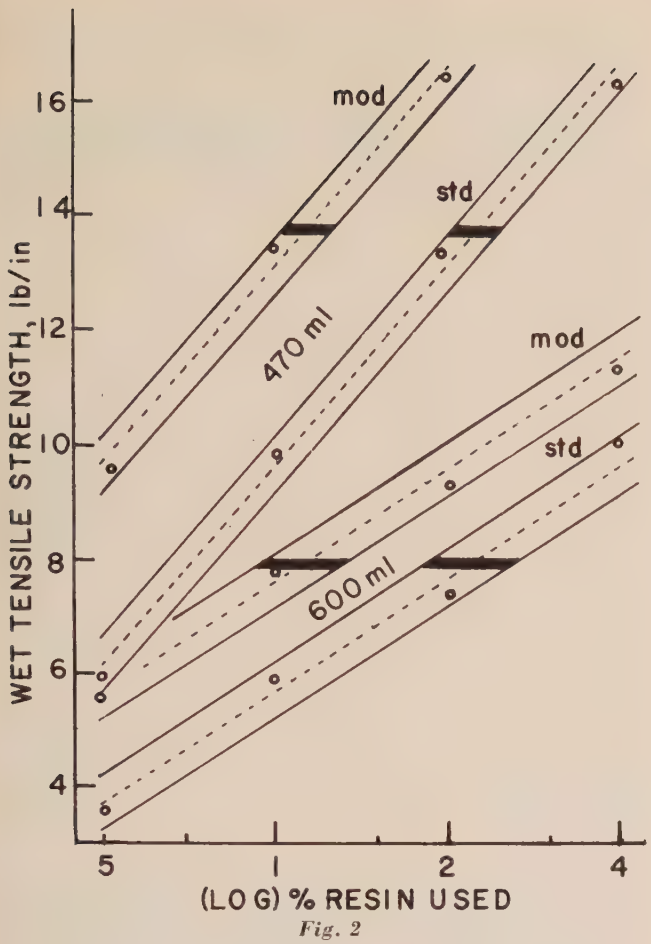

Fig. 2

As to detail, wet-strength resin testing usually takes the form of making handsheets containing the resins in question and then measuring the wet tensile strength of the sheets. To determine the relative efficiency of different resins, it is usually necessary to make comparisons at various concentrations of the resins in the sheet so that at equal wet strength the amounts of each resin required to give that wet strength can be ascertained. These comparisons are made easily when the wet strength is plotted against the amount of resin used on semilogarithmic paper. It was this plot which made it practical to consider increasing the slope of the effect versus treatment line. We have not seen this plot referred to in the literature but it seems to be analogous to Forman's (*1*) plot of dry tensile strength versus the logarithm of beating time. Strictly speaking the wet tensile should be plotted against the logarithm of the resin concentration in the sheet rather than of the resin added to the pulp; but since in the range of interest the resin retained by the pulp is nearly a linear function of that applied, the above approximation seems justified.

The difficulty in evaluating wet-strength resins arises from the fact that each point on the curve is uncertain with regard to wet strength. The curve really has two dimensions as does the rectangle in Fig. 1. In the two lower curves in Fig. 2 we have plotted the comparison of a standard resin and a modification of the resin which we are considering for development. It could be any two resins. Both resins were incorporated into handsheets at four different concentrations of resin solids based on dry fiber and tested for wet-tensile strength. The wet strength was plotted against the per cent resin used on semilogarithmic paper; these are the broken lines. The curve was given the width of our experimental error; this is the distance between the pairs of solid lines which represents the 90% confidence limits, ±0.5 lb. per in. The problem becomes more apparent if we consider, for example, 8.0 lb. wet-tensile strength. We see from the heavy black bands (which are analogous to the rectangle of Fig. 1) on the lower two curves that this wet strength can be obtained with 1.90 to 2.70% of the standard resin or with 0.95 to 1.35% of the modification. If we take extremes, i.e., the two percentages most favorable to the modification and then those least favorable and form the ratios 1.90 to 1.35 and 2.70 to 0.95 we find that it takes from 1.4 to 2.8 times as much of the standard as of the modification to obtain the same wet strength. Thus how much more efficient one resin is than another is quite uncertain under these conditions. These values were obtained from handsheets made on a Noble and Wood machine from unbleached kraft pulp beaten to 600 ml. Canadian freeness in a 1-lb. Valley beater. The TAPPI method was used to measure wet-tensile strength.

Now rather than repeat the above testing many times to get more significant results, we use a redesigned test method which has worked quite well. This improvement involves increasing the slope on the effect versus treatment line by exploiting the relationship of wet strength to pulp refinement. Maxwell, Reynolds, and House (*2*) have shown that a given amount of strength resin produces higher wet tensile in more highly beaten pulp. It is common experience that the per cent wet of dry tensile is about the same for the same resin treatment whether the paper is from highly beaten or lightly beaten stock. Since the dry tensile is higher in the more highly beaten stock the wet must be too. In the improved method resin comparisons are simply made with more highly beaten pulp in which wet strength is more sensitive to changes in resin concentration. As an example, the above resins were compared in pulp at 470 ml. instead of 600 ml. Canadian freeness; the experimental error was checked and the results plotted as before. Notice in the upper two curves in Fig. 2 that the increase in wet strength for doubling the resin dosage is about $3^1/_2$ lb. whereas this increase had been only 2 lb. per doubling in the less beaten pulp. If unbeaten pulp were used the response to doubling the resin might be less than 1 lb. less than the experimental error. The advantage of using the more highly beaten stock is apparent in the much shorter heavy black bands across the upper curves. Consider for convenience 13.8 lb. tensile strength. It can be obtained with 2.05 to 2.50% of the modified resin or with 1.05 to 1.25% of the standard. Again taking the extreme percentages and forming efficiency ratios as before we find that it takes from 1.6 to 2.4 times as much of the standard as of the modification to obtain the same wet strength. Recall that in the case of the lightly beaten pulp the corresponding figures were 1.4 to 2.8. Now the uncertainty in the efficiency ratio is just about half of what it was. Both sets of figures were obtained from the same number of tests. Of course, there is still room for improvement in the better set. This we know could be accomplished by performing more tests or employing a more highly beaten pulp, etc.

LITERATURE CITED

1. Forman, L. V., *Tappi* 33, No. 9: 444–50 (Sept., 1950).
2. Maxwell, C. S., Reynolds, W. F., and House, R. R., *Tappi* 34, No. 5: 233–238 (May, 1951).

Retention of Wet-Strength Resins by Various Types of Pulps

F. J. NEWHARD

This work represents a preliminary investigation concerning the retention of anionic and cationic urea-formaldehyde resins by various types of pulp under the influence of different catalytic agents. The results indicate the marked difference in the resin retaining ability of certain pulps, the difference in the retention of cationic versus anionic resins, and the effect of catalysts on resin retention.

During recent years, particularly since World War II, the search for better, more efficient wet-strength producing resins

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has been an ever increasing one. On the paper machine wet strength obtainable and in turn efficiency are governed by several factors: (1) the type and concentration of resin used; (2) the type and concentration of catalyst used in conjunction with the resin; (3) the manner in which the resin is applied or introduced either in beater addition, headbox addition, or spray application; (4) the prevailing machine conditions such as sheet uniformity, rate of drying, creping conditions, among others; and (5) the composition of the furnish.

In many instances this last factor, furnish composition, is overlooked especially in the production of certain grades of paper, such as toweling, where quality factors aside from wet strength are of prime importance and are usually more difficult to obtain. However, with the ever increasing speeds of the paper machines, it would seem that wet strength will eventually become one of the factors to be considered in determining a balanced furnish.

In brief, this investigation consisted of quantitative determinations of the amounts of resin and catalyst retained by various pulps. These pulps included: (1) an unbleached sulphite, (2) a bleached sulphite, (3) a bleached sulphate, and (4) an unbleached groundwood.

Two resins were used in this study. First, an anionic urea-formaldehyde resin having a specific gravity of 1.17, a viscosity of approximately 40 cp., and a pH of about 7.6. The other resin was a cationic type urea-formaldehyde resin having a specific gravity of 1.13 and a pH of 7.3.

Table I. Retention of Urea-Formaldehyde Resin—Anionic, %

Pulp	*Catalyst* $Al_2(SO_4)_3$	$NH_4H_2PO_4$	$MgCl_2$
Unbleached sulphite	33.3	36.6	30.1
Bleached sulphite	23.4	33.3	27.3
Bleached sulphate	22.8	22.2	8.2
Unbleached groundwood	27.5	25.6	17.9

In conjunction with the two resins and four pulps, three catalytic agents were used: (1) alum ($Al_2(SO_4)_3 \cdot 18H_2O$), (2) magnesium chloride, and (3) mono-ammonium phosphate.

EXPERIMENTAL

All of the retention tests were run on samples of pulp weighing 10 ±0.2 grams, and having 500 ml. of water associated with it—that is, a 1.96% consistency.

To obtain a 10-gram sample at the above-mentioned consistency, the following procedure was used:

1. Approximately 60 moisture-free grams of pulp were disintegrated for 1000 counts in a British disintegrator and subsequently diluted to 10 liters.
2. A volume containing 10 grams of pulp was measured from this diluted sample, and then filtered.
3. The pulp sample was then removed from the filter disk and then diluted so as to contain 480 ml. of water.

To each of the samples prepared in this manner, 1% catalyst (moisture-free fiber basis) was introduced. The pH was than adjusted to 4.5 using hydrochloric acid. Five per cent resin (moisture-free fiber basis) was then added, and the sample was allowed to agitate for a minimum of 2 min. The concentration of the resin and catalyst solution was regulated such that 10 ml. contained the desired quantity, 1% catalyst, and 5% resin, respectively. Thus, the addition of resin and catalyst brought the final volume of liquid associated with the pulp to exactly 500 ml.

The sample now containing resin and catalyst was again filtered. Two hundred and fifty milliliters of the filtrate was evaporated at 95°C., and the weight of residue determined.

Knowing the amount of residue, a per cent retention was calculated. Since the weight and consistency of the pulp samples and the resin and catalyst volumes were constant, the only correction factor to be applied was that determined through running blank tests on the individual pulps.

Surprisingly precise results were obtained using the above-described procedure—most of the individual tests fell within ±2% (units) of each other. With precision of this degree, comparison results such as the ones to follow, are justified. Since no other methods were used to check the data as obtained, no statement can be made concerning the accuracy of the results.

It should be understood that the retention data presented here include retention of both resin and catalyst.

DISCUSSION

In discussing the results, we will refer to the two tables of data.

As was anticipated the retention of cationic resins by *all* the pulps was far above that of the anionic urea-formaldehyde resin regardless of the type of catalyst used. An over-all average of 55% retention of cationic resin was found as compared to 26% retention of the anionic resin. This result was the most obvious one.

Table II. Retention of Tetramine-Formaldehyde Resin—Cationic, %

Pulp	*Catalyst* $Al_2(SO_4)_3$	$NH_4H_2PO_4$	$MgCl_2$
Unbleached sulphite	64.2	78.5	51.8
Bleached sulphite	48.9	53.3	39.1
Bleached sulphate	54.1	65.7	35.3
Unbleached groundwood	58.6	71.4	39.8

From these data, clear-cut differences in resin retention powers of the four pulps were displayed. For example, when using the cationic resin with mono-ammonium phosphate, the following classification according to resin retaining ability was obtained:

Unbleached sulphite	78.5%
Unbleached groundwood	71.4%
Bleached sulphate	65.7%
Bleached sulphite	53.3%

Here we can note the greater affinity for the cationic resin displayed by the unbleached in comparison to the bleached pulps. It is to be noted that groundwood is not inferior in respect to resin retention.

Considering the anionic resin with mono-ammonium phosphate the order displayed was somewhat different:

Unbleached sulphite	36.6
Bleached sulphite	33.3
Groundwood	25.6
Bleached sulphate	22.2

With one or two exceptions, this classification of pulps according to resin retaining ability remained the same for the other two catalysts, magnesium chloride and alum.

In comparing catalysts, it can be readily seen that mono-ammonium phosphate proves to be the superior catalytic agent of the three used in this study.

Considering only the data obtained for the cationic resin, average retention for all four pulps using mono-ammonium phosphate was 67.2% in comparison to 56.7% for alum and 41.5% for magnesium chloride.

A similar catalyst versus retention relationship was shown when using the anionic resin, only the differences were not as pronounced.

In conclusion, the results of this study as just described point up many of the problems faced by persons engaged in a wet-strength operation. Maximum wet strength at lowest cost is in most cases the objective. It certainly is hoped that methods such as the one described here will someday become the tools of the control groups in the paper mill to be used in achieving this objective.

Instrumentation Studies. LXXVII. Study on Gloss

I. A Goniophotometric Study of High-Gloss Papers

W. A. WINK, CYRIL H. DELEVANTI, JR., and J. A. VAN DEN AKKER

This study was initiated for the purpose of obtaining basic information on the distribution of light reflected from the surfaces of high-gloss papers—such as cast-coated and similar papers—with the hope that this information may ultimately lead to the development of a satisfactory procedure for evaluating the gloss of such papers. The evaluation of cast-coated papers with an instrument having the specifications given in TAPPI method T 480 m-51 is often misleading, and is not recommended, inasmuch as the numerical values obtained frequently fail to agree with visual estimates of gloss This is not intended as a criticism of the method, because there are many uncoated and calendered coated papers for which the method serves very adequately, but rather to point out that the new cast-coated and similar papers, which are a closer approximation to a mirrorlike reflector, present a problem in the measurement of gloss which lies beyond the scope of the present method. The existing photoelectric instruments conforming to the present method are equipped with a relatively large receptor aperture and are hence incapable of resolving differences in gloss which are visually discernible in the glossier types of paper. Measurements of the angular distribution of the intensity of the light reflected from the surfaces of coated and cast-coated papers for various fixed angles of illumination were made with a laboratory type goniophotometer which, for the purpose of achieving good resolution, was equipped with small source and receptor apertures. Fixed angles of illumination of 30, 45, 60, 75, and 80° (with respect to the perpendicular to the specimen) were involved in these measurements and the intensity of the reflected light was measured in each case, for an angular range of about 6°—i.e. 3° on each side of the angle of specular reflection. Goniophotometric curves for 20 samples of coated and cast-coated papers (six of which were colored papers) are presented. These curves have been examined from the point of view of correlating the peak values of the curves (for a given angle of incidence) and the half-widths of the curves (width of curve in degrees at the level of half the peak value) with values obtained on a Bausch and Lomb glossmeter and with visual gloss ratings. These examinations together with other considerations, have led to the following comments and conclusions: (1) the peak or maximum value of the goniophotometric curve appears to be one of the most significant properties related to the visual gloss of paper. (2) The peak value of the goniophotometric curve increases, in general, with the angle of incidence (referred to the perpendicular to the specimen). However, for some papers the ranking on the basis of peak value is changed when the angle of illumination is changed. This would indicate that the visual gloss for these papers may change with the angle of view. (3) A greater spread in peak values of the goniophotometric curves is observed for the smaller angles of illumination. (4) The half-width of the goniophotometric curve appears to be indicative of the quality of mirror images reflected from the surface of the paper, and is thus related to "shininess." (5) In general, the half-width of the curves decreases as the angle of illumination increases. (6) With one exception, high peak values of the curves are associated with small half-width values. This exception is a paper sample having a surface which appeared to consist of many small, irregularly shaped, highly glossy areas lying in an irregular plane. (7) The refractive index of the coated paper surface appears to have an effect on the peak value of the goniophotometric curve. (8) High peak values of the curves are associated with small half-width values for papers having coatings of a given index of refraction. This would indicate that for mill control purposes, a measurement of the peak values alone would be adequate for ranking papers in the correct order with regard to the visual sensations perceived relating to the intensity of the reflected rays and the quality of the mirrorlike images (distinctness-of-image gloss), provided that the index of refraction of the coating is constant. (9) For samples having a high visual gloss, the Bausch and Lomb glossmeter and the Ingersoll glarimeter are incapable of distinguishing small differences in gloss which are readily discernible with the goniophotometer. (10) The effect of color on the goniophotometric measurements for the glossier colored papers is expected to be small because the ratio of the intensity of specularly reflected light to diffusely reflected light is high. However, the color of the sample cannot be disregarded in visual ratings of gloss. (11) It is tentatively concluded from this work with the goniophotometric curves of "cast-coated" papers that physical quantities relating to the visual estimation of gloss for a given angle of illuminating and viewing are (a) peak value of the specular reflectance, (b) half-width of the peak (or any other suitable description of slenderness), (c) flatness of the paper surface, and (d) the color and luminosity of light diffusely reflected by the paper.

THE new cast-coated and similar papers have stimulated a renewed interest in gloss evaluation and they have brought to the foreground a problem in the measurement of this property which lies beyond the scope of the present TAPPI methods. The cast-coated papers, unlike ordinary calendered coated papers, have surfaces which visually produce the sensation of "shininess"—they are a much closer approximation to a mirrorlike reflector than are the surfaces of the calendered-coated papers. In the case of the cast-coated papers, observed highlights in the reflected rays are narrower and more sharply defined and crude images of surrounding objects can be perceived. This, in other words, would mean that one of the essential differences between the ordinary coated and cast-coated papers is that the light specularly reflected from the surface of a cast-coated paper is less spatially diffused than that reflected from the surface of a conventional coated paper.

Past attempts to evaluate the gloss of cast-coated papers with photoelectric instruments standardized in accordance with TAPPI method T 480 m-51 have been unsatisfactory. Invariably it was found that the

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instrumental readings failed to agree with the visual estimates of gloss—i.e., the instrument was incapable of resolving differences in gloss which were readily discernible to the eye. This situation is attributable primarily to the fact that the existing photoelectric instruments conforming to the present method are equipped with a receptor aperture which is too large to resolve the small-scale differences which are inherent in the reflecting properties of the cast-coated papers. (An obvious modification of the present instruments, which would greatly improve the resolution for this specific application, would involve the installation of much smaller source and receptor apertures. However, this would entail further modifications, since the addition of such apertures would cause a large-scale reduction in sensitivity.)

Because of the need for a satisfactory method for evaluating the gloss of high-gloss papers, this study was initiated for the purpose of obtaining, first of all, basic information on the reflecting properties of the glossier types of paper. The literature to date, although fairly extensive on the subject of gloss, yields very little information on the reflecting properties of the various glossier types of paper and no simple, but satisfactory, procedure has yet been suggested for the evaluation of gloss of this class of papers. The concepts of gloss, in general, involve a complex of visual sensations, and various types of instruments have been designed and constructed for the evaluation of specific properties. These concepts and procedures have already been described in great detail elsewhere and it is suggested that the reader refer to a paper by Hunter (*1*) in which he makes a distinction between six types of gloss, and to the book by Harrison (*2*) in which a complete review of the instruments and methods developed prior to 1945 is given together with an appraisal and discussion of the many aspects involved in the evaluation of the gloss of various materials.

In pursuing the objectives of this study, a laboratory type of goniophotometer was equipped with small source and receptor apertures for the purpose of achieving good resolution and then utilized to investigate the reflecting properties of 20 different coated and cast-coated papers. Data on the intensity distribution of the reflected light were obtained for various angles of illumination and these data were analyzed to determine their meaning with regard to our visual perceptions of gloss. For comparative and analytical purposes, gloss measurements were made with the Bausch and Lomb glossmeter and the Ingersoll glarimeter and data were obtained on the indexes of refraction of the surfaces of the papers. The following sections of this report give a detailed description of the goniophotometer employed throughout this study and present the pertinent data obtained in this investigation.

DESCRIPTION OF THE GONIOPHOTOMETER

A schematic diagram of the goniophotometer employed for this study is shown in Fig. 1. The main support for the instrument consists of a semicircular heavy brass plate 1. Two movable arms 2 and 3 are attached to the plate in such a manner that they pivot about the point 0 and can thus be adjusted to various angular positions. The peripheral edge of the base is graduated in degrees to facilitate the setting of either arm to any desired angular position.

The left arm 2 serves as a support for the light source and pertinent parts of the illuminating system. The lamp housing 15 contains a 6-v., 32 c.p. lamp having a single, straight-spiral filament. The lamp is mounted

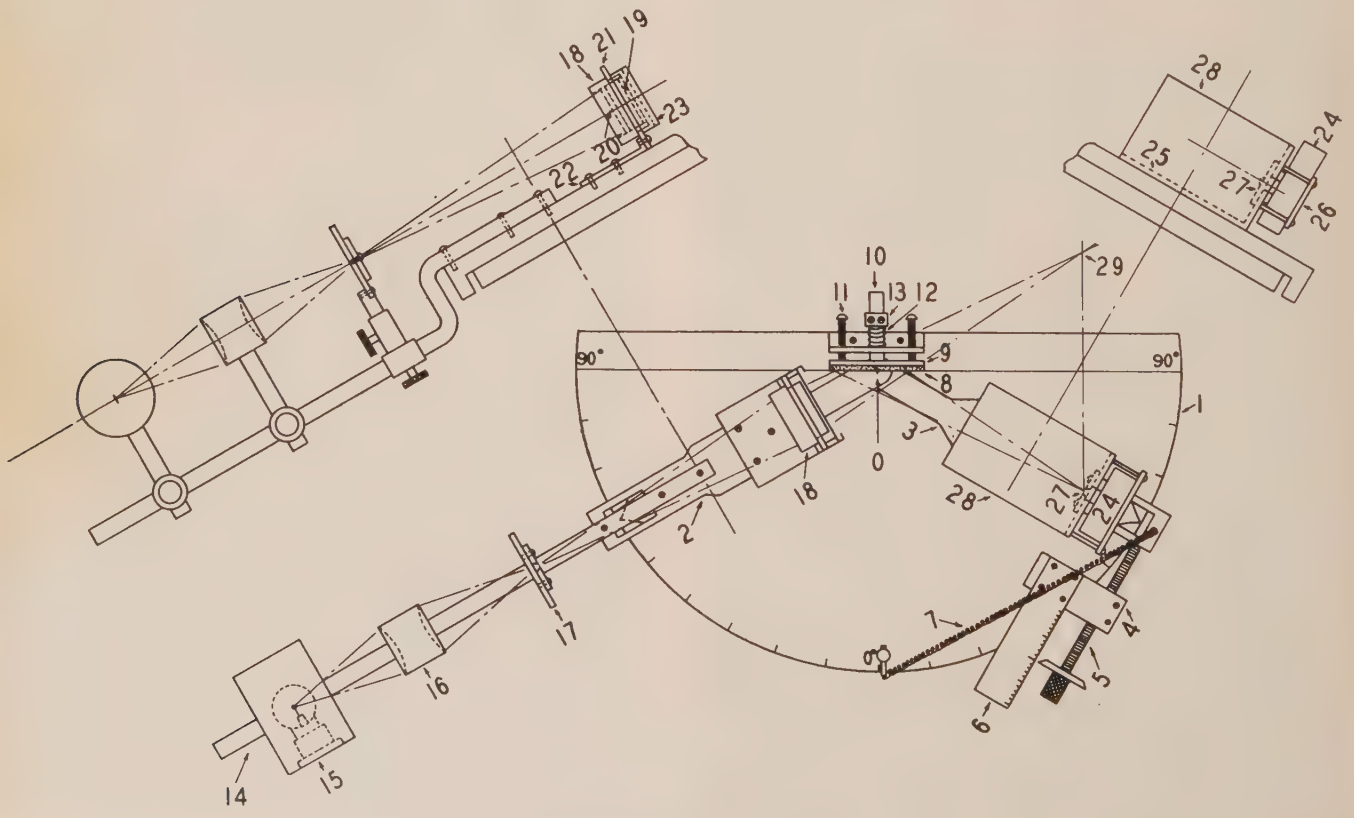

Fig. 1. Schematic diagram of goniophotometer

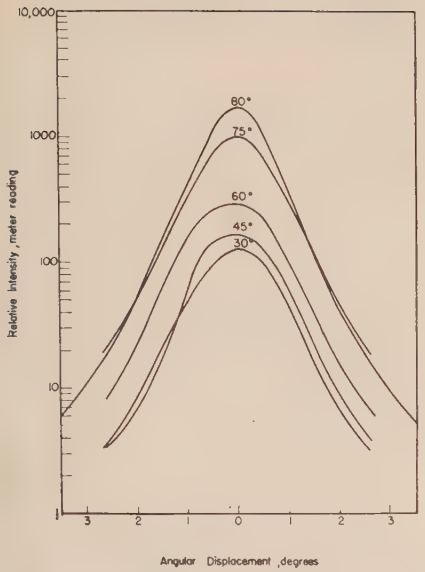

Fig. 2. Sample 1. Intensity distribution curves of reflected light for five different angles of illumination

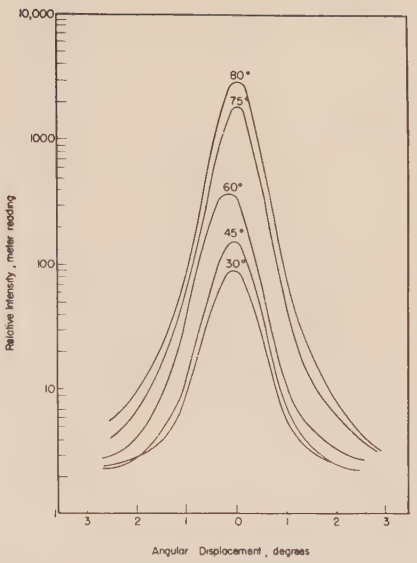

Fig. 3. Sample 2. Intensity distribution curves of reflected light for five different angles of illumination

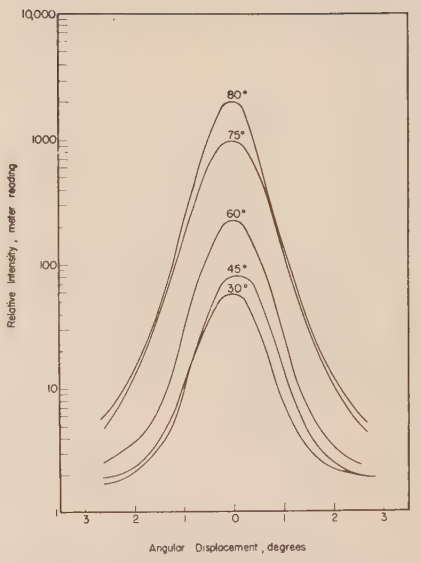

Fig. 4. Sample 3. Intensity distribution curves of reflected light for five different angles of illumination

with the axis of the filament normal to the base plate of the instrument. In the interest of providing a constant source of illumination, the power for the lamp is obtained from a constant-voltage transformer. Light leaves the lamp housing through a 1-in. diameter opening in the side of the wall.

The filament of the lamp is focused on slit 17 by means of the condensing lens 16. This is a double plano-convex lens combination having a diameter of 32 mm. and a focal length of about 63 mm. The slit 17 has straight, sharp, beveled edges; it is an adjustable slit and for this study was set at a height of 3.5 mm. and a width of 0.5 mm.

The second lens 18 in the illuminating system is achromatic; it has a diameter of 32 mm. and a focal length of about 140 mm. This lens is positioned so that the slit 17 is focused, after reflection from the sample surface, on slit 27, which is located in front of the phototube. The distance between the specimen and the receptor slit is 200 mm., so that the angular size of this slit relative to the specimen position is 0.14°.

A simple holder 23 is attached to the sample side of lens 18 to accommodate apertures of various widths which are used to confine the light beam on the sample holder when the incident beam is set at a grazing angle with respect to the sample.

The right arm 3 serves as a support for the phototube and other pertinent parts of the light-receptor system. The intensity of the light reflected from the surface of the sample is measured with a Densichron (manufactured by the W. M. Welch Manufacturing Co., Chicago, Ill.). This instrument has good sensitivity, and, although it suffers somewhat from the standpoint of linearity, it adequately covered the requirements of this investigation. The instrument, as a unit, is provided with a phototube, an amplifier, and an output meter. Four sensitivity ranges, differing by factors of 10, and a volume control for adjusting the over-all response, are provided by the instrument. The blue-sensitive phototube with which the instrument is normally furnished was used throughout this investigation.

The phototube probe unit 24 of the Densichron is securely attached to the movable arm 3 by means of an L-shaped bracket 25. Immediately in front of the phototube is a straight, sharp, beveled-edge slit 27. This slit was adjusted to a width of 0.5 mm. (the same as the width employed for slit 17) and to a height of 10.5 mm.

To prevent stray light from entering the slit 27 a light shield 28 lined with black velour paper is provided.

The sample holder 8, consists essentially of a sintered porous bronze disk having a thickness of $^1/_8$ in. and a diameter of $2^1/_4$ in. This disk is supported at the edge by means of a cavity so that through the application of a vacuum the surface of the test specimen is held flat against the front flat surface of the sintered disk. In the preparation of the sintered disk all impregnated oil was removed from the porous structure by repeated soaking in benzene. This was done to render the disk sufficiently porous for the desired application and to avoid subsequent contamination of the test specimens. The desired degree of flatness of the disk was obtained by grinding one of the surfaces with no. 220 carborundum powder on a piece of polished plate glass. It may be of interest to mention here that other attempts to produce a flat surface on the sintered bronze, such as surface grinding with a high-speed grinding wheel and machining in a lathe (taking cuts of various depths with a sharp tool), resulted in failure since these tools tended to close the pores and thus destroy the porosity of the disk.

An L-shaped bracket forms the basic support for the porous sample holder. Three screws 11 provide a three-point mounting for the porous disk and permit adjustment so that the front surface of the disk can be aligned with respect to the optical axis of the illuminating and receiving system of the instrument.

For relatively porous materials the vacuum applied to the sintered disk with a mechanical pump or with a water aspirator is more than adequate to hold the sample firmly in place; for nonporous materials, like the glass standard, some difficulty is encountered in removing the standard without some provision for releasing the vacuum. The vacuum line was therefore equipped with a three-way stopcock.

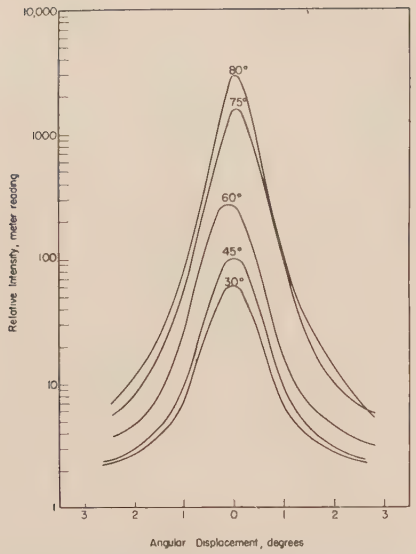

Fig. 5. Sample 4. Intensity distribution curves of reflected light for five different angles of illumination

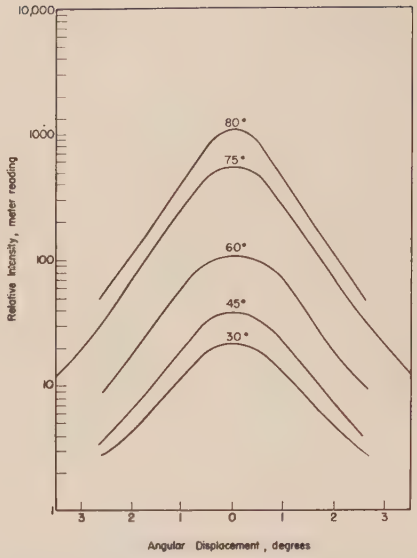

Fig. 6. Sample 5. Intensity distribution curves of reflected light for five different angles of illumination

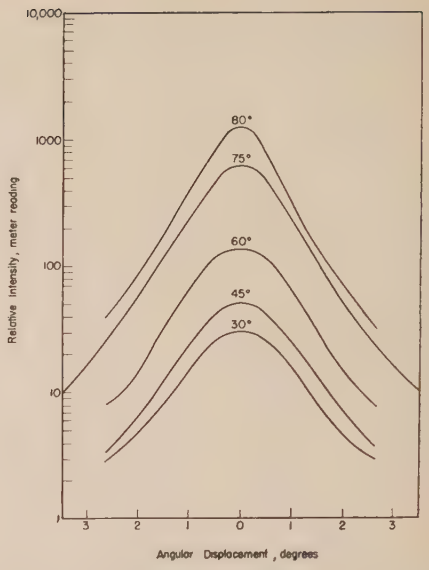

Fig. 7. Sample 6. Intensity distribution curves of reflected light for five different angles of illumination

The attachment 4 facilitates accurate scanning of the reflected beam of light. This attachment consists of a U-shaped piece which is firmly clamped to the periphery of the base plate at any desired position by means of a thumb-screw on the bottom; a 3-in. screw 5 having 32 threads per in. which snugly fits and turns through the piece 4, and a zero center scale 6 which is graduated in $^1/_{32}$-in. intervals. The screw 5 is provided with a graduated dial to facilitate reading of the scale and to permit adjustment of the angular position of the receptor to the desired tolerances. The arm 3 of the receptor system is held in intimate contact with the end of the 3-in. screw by means of the spring 7. Hence, turning of the screw 5 displaces the receptor system by any desired known amount over a total angular range of about 8°.

All the optical components consisting of the lamp, the apertures, the slits, and the phototube are aligned on a common optical axis with respect to the front surface of the sample holder. The slit 17 and the lens 18 are positioned so that the image of slit 17 after reflection from the surface of the sample holder is focused, without magnification, on the receptor slit 27. This condition obtains when the image and object distances for the lens 18 are equal. The instrument was considered to be in true alignment when, with a thin flat front surfaced mirror on the sample holder, the angles of incidence and reflection coincided for the whole range of angular settings.

The instrument is of open type construction and, because of this, it is used either under a shielded enclosure or in a dark room. Throughout this study all precautions were exercised, by proper shielding, to eliminate stray light as a possible source of error.

OPTICAL PRINCIPLES

The optical principles of the goniophotometer may best be described with continued reference to Fig. 1. The light originating from the lamp and illuminating the slit 17 is collected by the lens 18 and, after specular reflection from a flat surface held by the sample holder, comes to a focus at slit 27. Since slits 17 and 27 are the same width by construction, all light reflected from a perfectly flat mirror surface will, under ideal conditions, enter slit 27 when the latter is adjusted to an angular position which coincides with the angles of specular reflection. Thus, for the perfect reflector one would obtain, upon plotting the intensity of the reflected light as a function of the angular displacement of the slit 27 (linear coordinates), a curve having the shape of an equilateral triangle with the vertex at the angle of maximum reflection and the width at the base corresponding to twice the width of the slits. If the slits were of unequal size the curve would have a plateau at the vertex equal to the difference in the slit widths and the width at the base, as before, would be equal to the sum of the slit widths. These ideal conditions are not quite realized, however, primarily because of inevitable light scattering by the optical components and partly because of imperfections in the optical image of slit 17.

If the ideally perfect mirror reflector is replaced with a paper sample, most of the light will be diffusely reflected. By moving the slit 27 to different angular positions about the position of maximum reflection, the angular intensity distribution will be obtained for the reflected light which lies in the plane defined by the incident beam of light and the normal to the paper.

Inasmuch as the front surface of the sample holder lies in a fixed plane, there is a translational shift of the reflected beam toward smaller angles as the thickness of the sample is increased and also a defocusing of the image at the slit 27. The shift in the reflected beam is a measurable quantity, but the defocusing effect is negligibly small for the series of samples employed in this study. Since the data of interest in this work involve the measurement of the angular distribution of the reflected beam with respect to the specular angle rather than with respect to an angle equal to the angle of incidence, any effects of the displacement of the reflected beam can be disregarded. By redesigning the sample holder and providing stops so that the front surface of the sample, rather than the front surface of the sample holder, remains in a fixed plane, the two effects just mentioned are eliminated. (This improvement has now been made.)

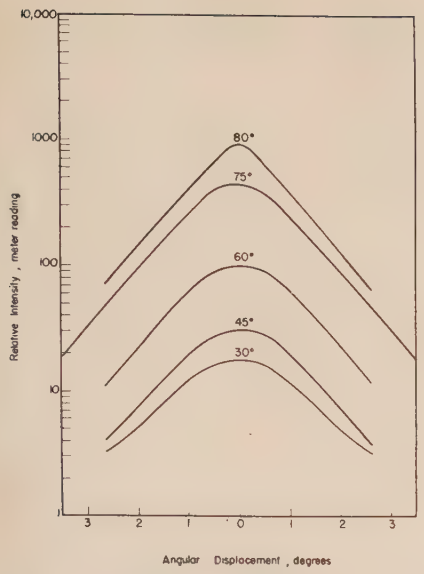

Fig. 8. Sample 7. Intensity distribution curees of reflected light for five different angles of illumination

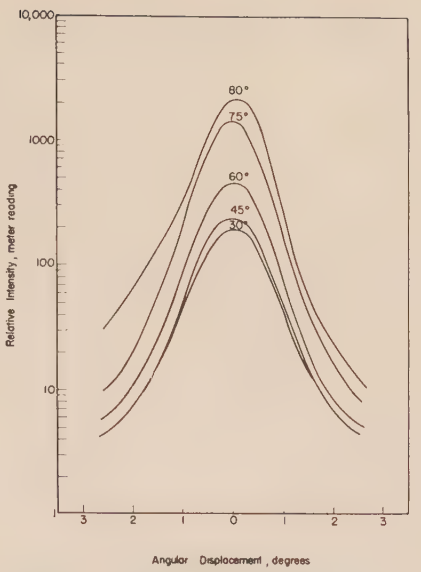

Fig. 9. Sample 8. Intensity distribution curves of reflected light for five different angles of illumination

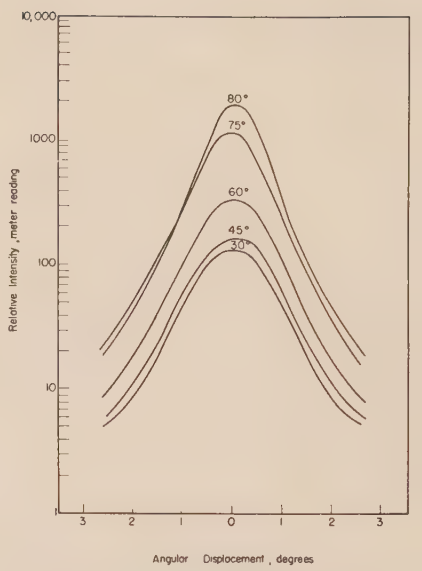

Fig. 10. Sample 9. Intensity distribution curves of reflected light for five different angles of illumination

PROCEDURE FOR OBTAINING DATA

The procedure employed for obtaining the angular distribution of the intensity of the light reflected from the surface of a sample for a given angle of illumination is as follows: The illuminating system (see Fig. 1) is set at a desired angle of incidence and, for the measurements made at angles of 75° and smaller, a fixed slit $^5/_8$ in. in width is placed in the holder 23. A test specimen is temporarily placed on the sample holder and the receptor system is positioned on the center of the axis of the reflected beam of light. This axis is easily located by manually moving the receptor system to obtain a maximum reading on the meter of the Densichron. When the position yielding the maximum reading is found, the U-shaped piece 4 (with the dial set on zero) is clamped to the base of the instrument with the screw 5 in contact with the side of the receptor arm 3. The spring 7 is then also attached to the base plate at a point where the tension will be sufficient to hold the receptor arm in positive contact with the spherical end of the screw 5 for the entire travel of the screw. A final check is made by turning the screw to be sure that the position of maximum intensity falls close to the mid-scale zero mark on the scale 6.

The above preliminary adjustments are made primarily as a convenience for the subsequent plotting of the results. The time-consuming process of correcting the data to a common basis is avoided and the instrumental values are thus directly comparable. If, however, the point of maximum intensity and the zero on the scale should fail to be in exact agreement, the plotted results would merely be displaced slightly to the right or left of the zero axis.

For measurements made at an angle of illumination of 80°, a slit having a width of $^1/_4$ in. is employed in the holder 23, in order to confine the incident beam of light to the test area of the sample. Since the substitution of the $^1/_4$-in. slit for the $^5/_8$-in. slit results in a reduction in intensity of illuminating beam, all instrumental readings obtained with the smaller slit are multiplied by 2.16 (experimentally determined) in order to place the data on a common scale with the data obtained at the smaller angles of incidence.

Following the preliminary adjustments, the paper specimen is temporarily removed and a piece of polished black glass having a refractive index of 1.54 is placed on the sample holder for standardization of the instrument. The zero of the instrument is checked and adjusted (with the light blocked out) and the control knobs on the Densichron are then adjusted to obtain a meter indication corresponding to the reflectance value for the black glass standard. Since the reflectance of the glass standard is a function of the angle of illumination, the meter setting on the Densichron is different for each angle of incidence. The reflectivity values for the glass standard are readily obtainable from calculations based on an equation due to Fresnel, which states that:

$$I_{\text{refl.}}/I_0 = (^1/_2)\,([\sin^2(i-r)/\sin^2(i+r)] + [\tan^2(i-r)/\tan^2(i+r)]) \quad (1)$$

where

$I_{\text{refl.}}$ = the intensity of the reflected beam
I_0 = the intensity of the incident beam
i = the angle of incidence
r = the angle of refraction

The angles i and r are related to Snell's law which states that:

$$n = \sin i/\sin r \quad (2)$$

where n is the refractive index of the glass. The calculated reflectivity values for the black glass standard for the various angles of incidence employed in this study are presented in Table I.

After standardization of the instrument, the paper specimen is carefully centered over the sample holder and instrumental readings are obtained for the various angular positions of the receptor system. The angular range and the number of readings required for adequately defining the intensity distribution curve are governed, in part, by the surface characteristics of the sample. For papers having the glossier mirrorlike surface (those for which the intensity is critically dependent on angular displacement of the receptor) the readings are taken at small angular increments over a small angular range (on each side of the angle of maximum intensity) whereas for the less glossy papers the

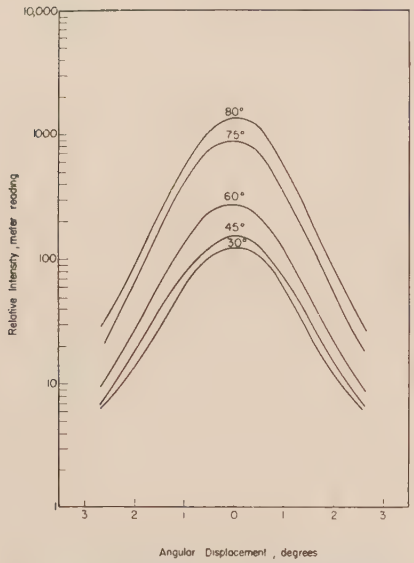

Fig. 11. Sample 10. Intensity distribution curves of reflected light for five different angles of illumination

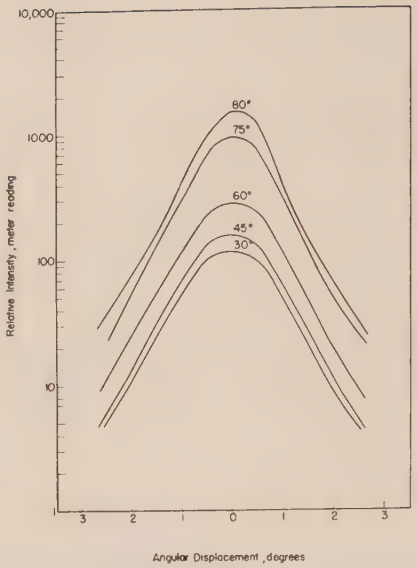

Fig. 12. Sample 11. Intensity distribution curves of reflected light for five different angles of illumination

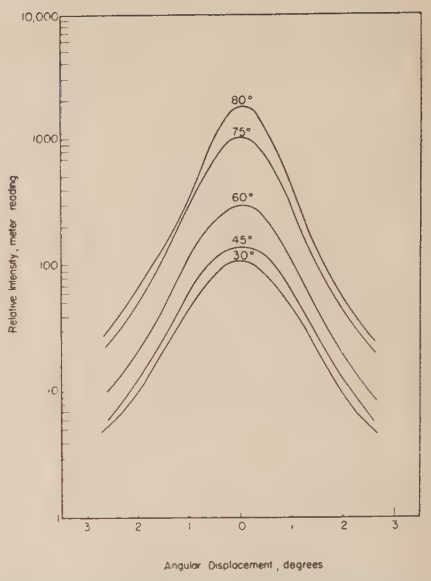

Fig. 13. Sample 12. Intensity distribution curves of reflected light for five different angles of illumination

readings are taken at somewhat larger angular increments and over a relatively larger angular range. The relative intensity values obtained in the foregoing manner are plotted as a function of the angular displacement of the receptor on four-cycle semilogarithmic chart paper to facilitate the subsequent interpretation and comparison of the data.

Table I. Reflectance of the Black Glass Standard for Various Angles of Incidence

Angle of incidence, degrees	*Calculated reflectance*	*Calculated meter setting for range 0*
30	0.0467	16.7
45	0.0559	20.0
60	0.0958	34.3
75	0.260	93.0
80	0.394	43.0[a]

[a] With the 1/4-in. slit over the holder 23 (Fig. 1).

PROCEDURES FOR OBTAINING SUPPLEMENTARY GLOSS DATA

TAPPI methods T 480 m-51 and T 424 m-45 were employed, respectively, for evaluating the specular gloss of the samples at 75° with the Bausch and Lomb glossmeter and the contrast gloss at 57.5° with the Ingersoll glarimeter. With regard to the latter, the effect of color in the evaluation of colored samples was minimized by inserting appropriately colored filters in the incident light beam of the instrument.

The procedure for evaluating the refractive indexes of the paper surfaces involved measurement of the Brewster angle or, in other words, a direct application of Brewster's law which states that, for dielectric materials, the maximum polarization of the reflected rays occurs when the reflected and refracted rays are 90° apart. Thus,

$$n = \tan \Theta$$

where n is the index of refraction of the material and Θ is the angle of maximum polarization of the reflected rays.

The angle Θ is evaluated with the goniophotometer in the following way. A Polaroid inserted between the sample holder and the slit 27 is oriented to obtain the maximum extinction of the reflected light as observed on the meter of the Densichron. The receptor is then positioned to give a maximum meter reading for the given angle of incidence. New angles of incidence are subsequently tried and the corresponding peak intensities observed on the meter. As the angle of maximum polarization is approached, the peak intensity becomes smaller and approaches a minimum value at the angle of polarization. At the position yielding the minimum peak value, the angle of incidence Θ is carefully determined with respect to the normal to the surface of the paper.

RESULTS AND DISCUSSION

Intensity distribution curves were obtained for 20 different samples of paper at five different angles of illumination—30, 45, 60, 75, and 80°. Seven of the 20 samples evaluated were white papers of the cast-coated type, six were colored papers also of the cast-coated type, and the remaining seven samples were white papers having the ordinary type of coating.

The intensity distribution curves for the samples of paper are presented in Figs. 2 to 21 and, for comparative purposes, the curve for the black glass standard is presented in Fig. 22. Other instrumental results and the data involved in the treatment and analysis of the goniophotometric curves are presented in Table II. These include (1) the refractive indexes of the paper surfaces, (2) specular gloss as determined with the Bausch and Lomb glossmeter in accordance with TAPPI method T 480 m-51, (3) contrast gloss as determined with the Ingersoll glarimeter in accordance with TAPPI method T 424 m-45, (4) the maximum intensity or peak values of the goniophotometric curves for the different angles of illumination, and (5) the widths of the goniophotometric curves ("half-widths") in degrees at a level of half the peak values.

Inasmuch as the significance of the instrumentally evaluated properties concerning gloss are ultimately judged by the impressions made upon the human eye, subjective evaluations of the samples employed have by necessity become a part of this study. The samples

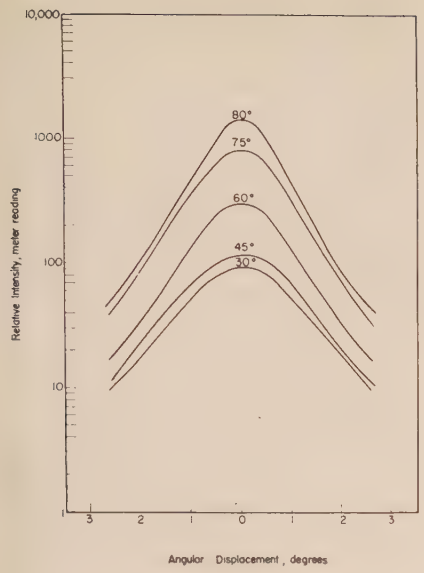

Fig. 14. Sample 13. Intensity distribution curves of reflected light for five different angles of illumination

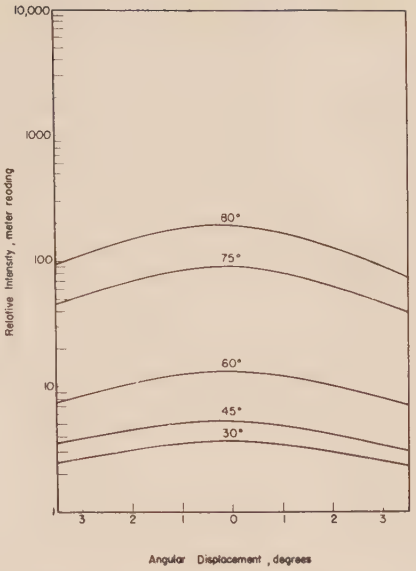

Fig. 15. Sample 14. Intensity distribution curves of reflected light for five different angles of illumination

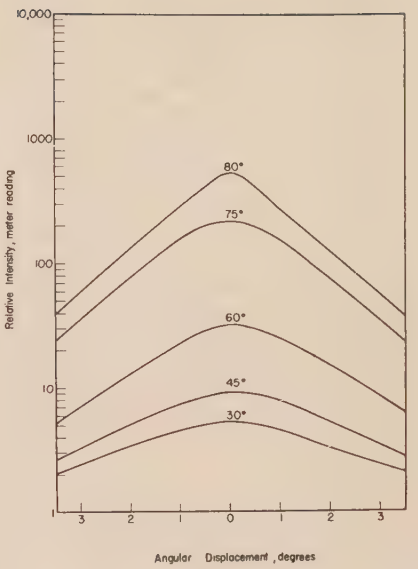

Fig. 16. Sample 15. Intensity distribution curves of reflected light for five different angles of illumination

were arranged with respect to the ranking established by the instrumental values of a given property and then the visual sensations that were perceived were considered in relation to the instrumental results.

In a comparison of the peak values of the goniophotometric curves with the sensations perceived relating to the intensity of the reflected rays, it would appear that the maximum or peak value of the curve is the most significant single property governing visual gloss. When the samples of a given index of refraction were arranged with respect to the peak values, the visual sensations confirmed the ranking established by the instrumental values.

The peak intensity of reflection for a given sample increases with the angle of incidence, with the rate of increase becoming greater as the angle of incidence approaches 90°. These effects are general for all dielectric materials having a flat continuous surface and are indicated by the previously referred to Fresnel equation. (Because of the imperfect surface of paper, the surface reflecting properties of the paper are not expected to follow the Fresnel equation closely and, of course, the sheet diffusely reflects light.)

Although the peak value for a given sample increases with the angle of incidence, the peak values for all samples do not always occur in the same order for the different angles of incidence. For example, the peak value for sample 1 is observed to be higher than that for sample 2 at the smaller angles of incidence, whereas at the larger angles of incidence, which would be at the grazing angles, the order is reversed and the peak value for sample 2 is the higher. This reversal can be observed visually and is attributable to the surface characteristics of sample 1 and to differences in the refractive indexes of the coatings; a further discussion of these two properties will appear later in this report.

The spread in peak values will be observed to diminish as the angle of incidence is increased. This effect is to be expected for dielectric materials; calculations based on the Fresnel equation show that a reflectance value of unity will be obtained for all perfectly smooth and flat dielectric materials when the angle of incidence is 90°. Thus, as the angle of incidence approaches 90° the reflectance will, according to theory, approach unity as a theoretical maximum and the ability to distinguish the finer differences in gloss be-

Table II. Data on Coated and Cast-Coated Papers

	Sample	Refractive index	Ingersoll gloss, %	B & L gloss, %	Maximum relative intensity values, peaks 30°	45°	60°	75°	80°	Half-width of curve, degrees 30°	45°	60°	75°	80°
1.	White cast-coated	1.55	96.1	99	135	180	320	1050	1800	1.60	1.69	1.78	1.50	1.21
2.	White cast-coated	1.34	87.1	85	92	160	390	1900	3100	0.89	0.82	0.81	0.61	0.62
3.	White cast-coated	1.31	88.3	76	60	100	270	1600	2900	0.92	0.92	0.88	0.62	0.60
4.	White cast-coated	1.31	89.4	77	56	82	230	1000	2050	1.11	1.12	1.05	1.15	0.85
5.	White cast-coated	1.33	88.6	77	31	52	140	650	1300	2.02	2.01	1.99	1.60	1.31
6.	White cast-coated	1.29	88.3	75	21	38	110	550	1050	2.27	2.15	2.28	1.90	1.60
7.	White cast-coated	1.31	87.1	75	18	32	100	460	960	2.69	2.50	2.51	2.30	1.72
8.	Yellow cast-coated	1.57	96.7	99	190	240	450	1400	2200	1.30	1.30	1.22	1.10	1.09
9.	Black cast-coated	1.55	98.9	102	140	170	350	1200	2100	1.60	1.62	1.95	1.25	1.02
10.	Green cast-coated	1.57	99.0	96	125	150	280	880	1350	1.95	1.90	1.90	1.82	1.70
11.	Blue cast-coated	1.56	99.0	98	120	160	300	1000	1500	1.90	1.78	1.75	1.49	1.46
12.	Red cast-coated	1.56	97.0	99	115	140	300	1050	1850	1.75	1.87	1.64	1.43	1.21
13.	Cream cast-coated	1.57	95.8	99	98	120	250	840	1420	2.14	2.22	1.95	1.79	1.53
14.	White coated	[a]	82.9	45	3.7	5.5	13.5	90	190	[b]	[b]	[b]	6.68	6.42
15.	White coated	1.43	78.8	56	5.4	9.4	32	240	560	5.83	4.55	3.42	3.00	2.01
16.	White coated	1.43	89.5	76	16	29	91	480	890	3.07	2.67	2.67	2.30	2.01
17.	White coated	[a]	84.8	60	5.0	8.5	28	170	350	[b]	5.88	4.83	4.61	4.28
18.	White coated	[a]	81.5	58	3.6	6.2	22	160	340	[b]	7.00	5.81	5.12	4.71
19.	White coated	[a]	89.5	76	14	24	70	340	630	4.21	4.00	3.75	3.25	2.74
20.	White coated	[a]	88.3	74	19	33	99	470	840	2.40	2.41	2.38	2.11	1.62

[a] No sharp measurement.
[b] Off scale values.

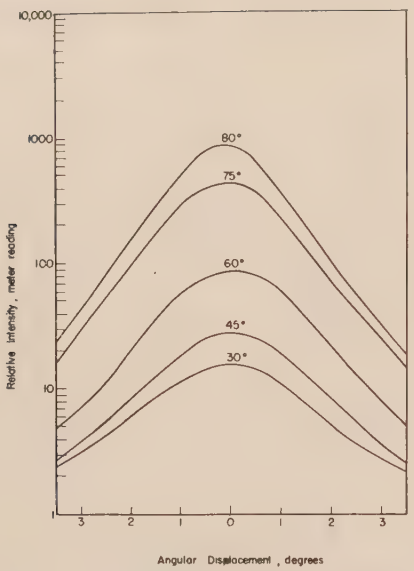

Fig. 17. Sample 16. Intensity distribution curves of reflected light for five different angles of illumination

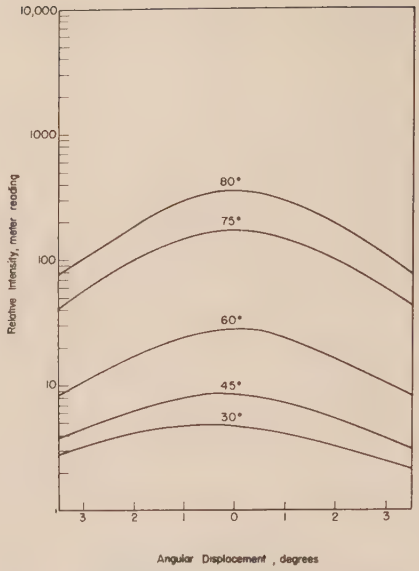

Fig. 18. Sample 17. Intensity distribution curves of reflected light for five different angles of illumination

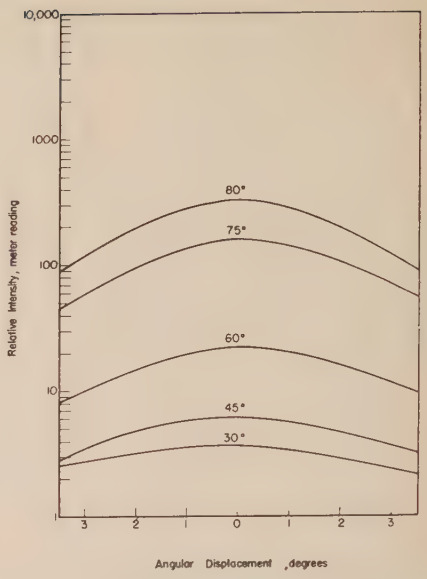

Fig. 19. Sample 18. Intensity distribution curves of reflected light for five different angles of illumination

comes minimal. This single effect of the angle of incidence favors the use of a small angle (relative to the perpendicular) for the evaluation of gloss of *high-gloss* papers.

The sensations perceived when examining the quality of the mirrorlike images reflected from the samples at the various angles of view were found to agree with the half-width values of the curves—i.e., the images observed with the samples having the smaller half-widths were more distinct than those observed with the samples having the larger half-width values. It would therefore appear, on the basis of the data obtained for this series of samples, that a measurement of the half-width may serve as a valid means for evaluating the type of gloss referred to as distinctness-of-image gloss.

With a few exceptions, the half-widths of the curves decrease as the angle of incidence increases. The departures from this general trend are irregular, are mostly of a low order of magnitude, and are possibly insignificant.

With the exception of sample 1, a small half-width is associated with a high peak value. In the case of sample 1, however, two distinct differences from the other samples were observed. First, it will be noted that both the peak and half-width values for the various angles of incidence are unusually high and, second, it was observed in our visual examinations that, although the sample appeared to be properly ranked with respect to the peak value, the sample at the smaller angles of incidence had the appearance of being much more "shiny" than would be indicated by the peak value. This departure of sample 1 from the general pattern established by the other white samples is attributed to the unusual surface characteristics of the coating. When the surface of this sample was viewed at small angles to the normal of the surface, the surface had the appearance of being composed of many small irregularly shaped, highly glossy areas lying in irregular planes. These areas apparently gave rise to the high peak and and half-width values in much the same way a shattered mirror would yield a large number of intense multiple images. It was an interesting observation that the quality of the images reflected from this sample could be improved substantially by simply bending the surface of the paper into a slight cylinder so that the grosser irregularities in the profile of the surface were removed.

Reasonably distinct images are formed at the lower angles of view to the normal with all samples for which the half-width value is less than one degree. When the half-width is above this value the image of a light source deteriorates into a highlighted area on the surface. At larger angles (approaching grazing incidence) the half-width becomes smaller and crude images are formed in the case of samples of inferior gloss (a familiar phenomenon).

The goniophotometric curves for the colored samples are observed to approach the shapes of the curves obtained for the white sample 1; this, in accordance with the foregoing interpretations, would mean that the reflecting properties of the colored papers are similar to those of sample 1. Of the colored papers the yellow sample (no. 8) having the high narrow peak was observed to be the glossiest; the cream colored sample (no. 13) having the low broad peak was the least glossy.

The color of the sample cannot be disregarded in judging visual gloss. In general, when two colored papers with identical specular reflectance characteristics are visually judged, the darker colored paper will appear the glossier because of the greater contrast between the background and the reflected high lights.

The effect of color can be minimized when, in viewing the samples in white light, the samples are viewed at grazing angles. At the grazing angles, the diffuse component is minimized and the color of the specularly reflected light is very nearly that of the light source. The effect of color may also be minimized by viewing the samples with a light source in a dark room where the diffuse reflection of light from the walls is greatly reduced. The ratio of the intensity of diffuse to specularly reflected light, which in a well-lighted room is high, will be lower in a room with dark walls and the effect of color will be correspondingly low.

For the series of papers employed in this study, it will be observed that the indexes of refraction of the surfaces

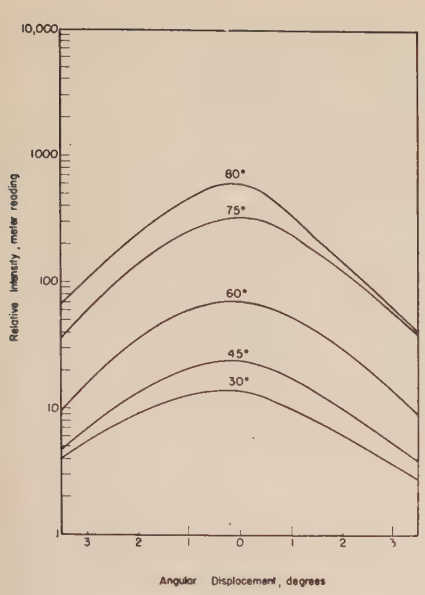

Fig. 20. Sample 19. Intensity distribution curves of reflected light for five different angles of illumination

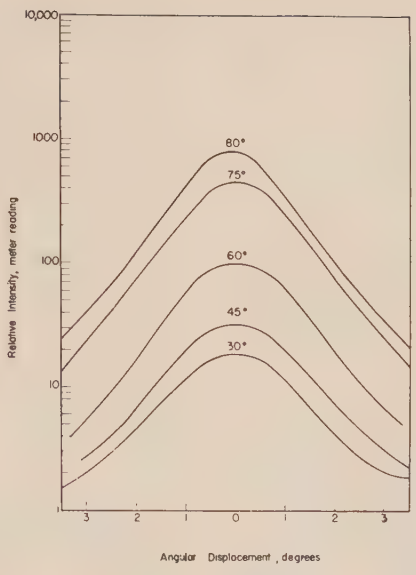

Fig. 21. Sample 20. Intensity distribution curves of reflected light for five different angles of illumination

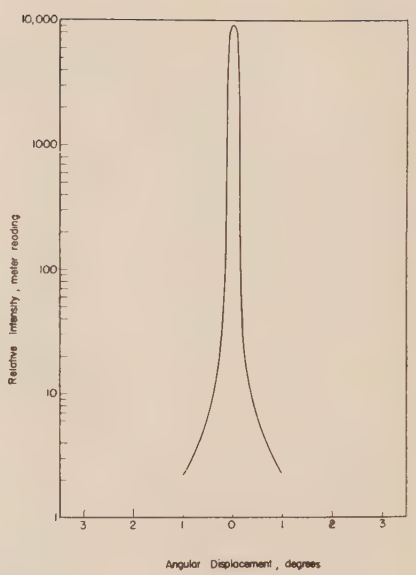

Fig. 22. Intensity distribution curve of reflected light for polished black glass standard at angle of illumination of 75°

of the samples varied from a minimum of 1.29 to a maximum of 1.57 and that the indexes for the cast-coated papers all fell within two relatively narrow ranges. The average index for the colored papers and one white paper—namely, sample 1—is observed to be 1.56 whereas that for the remaining white papers, samples 2 to 7, is observed to be 1.32. This difference in the index of refraction is of a sufficient order of magnitude to have a significant effect on the goniophotometric data and, consequently, on the evaluation of the gloss of high-gloss papers.

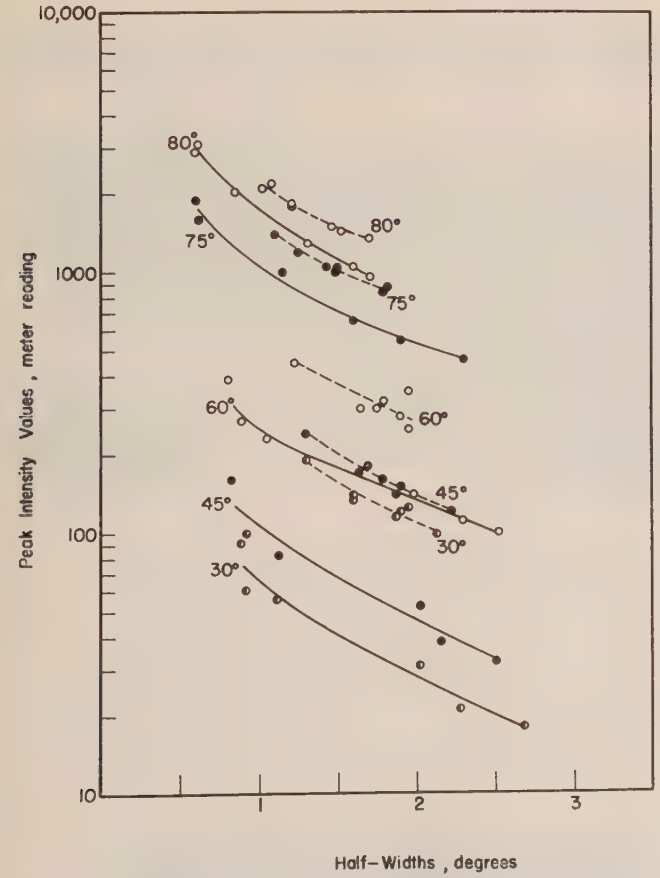

Fig. 23. Curves for the cast-coated papers showing the relationship between the peak intensity and half-width values. The solid lines are for papers having an index of refraction averaging 1.32 and the dotted lines are for papers having an index of refraction averaging 1.56

In accordance with theoretical considerations, it will be noted that the papers having the lower index of refraction show a greater dependence on the angle of illumination than do the papers having the higher index. The ratios of the peak values at 30 and 80° were found to average 0.023 for the papers having an index of 1.32 and 0.076 for the papers having an index of 1.56. As a matter of interest, calculations based on the Fresnel equation show that the ratios of the reflectances (for corresponding angles) for dielectric materials having indexes of 1.32 and 1.56 are 0.058 and 0.124, respectively.

When the peak values of the goniophotometric curves are plotted as a function of the half-width values for the various angles of illumination, the same grouping of the samples with respect to the index of refraction is obtained. These curves are shown in Fig. 23 where the solid lines represent the curves obtained for the papers having an index of refraction of 1.32 and the dotted lines represent the curves obtained for the papers having an index of 1.56. It is of interest to note that at each angle of incidence, the points for the white sample 1 (the paper with an unusual surface and an index of 1.56) fall closely on the dotted curves along with the points for the colored papers. It should be noted that the relative difference between each pair of curves for a given angle of incidence increases with decreasing angle. This suggests that the refractive index has more effect on the peak and half-width values (and consequently on the visual gloss) at the smaller angles than for grazing angles.

Since the papers of a given index of refraction were found to be instrumentally ranked in accordance with visual gloss, the good relationship between the peak and half-width values may be of immediate practical value for mill control purposes. The limited data thus far obtained would suggest that, if the index of refraction were controlled to within relatively narrow limits, a simple measurement of the peak value could be em-

ployed to rank the papers in the correct order with regard to both (1) the visual sensations of gloss relating to the intensity of the reflected rays and (2) the quality of the mirrorlike images that are formed by the surfaces (distinctness-of-image gloss). However, when the indexes are different, it would appear that the evaluation of the gloss of high-gloss papers must involve both a measurement of the peak and the half-width. Whether an instrument is designed to measure peak value alone, or both peak value and half-width, the angular sizes of the source and receptor slits should be made small relative to the smallest half-widths to be encountered.

Upon comparing the specular gloss values (obtained with the Bausch and Lomb glossmeter) and the contrast gloss values (obtained with the Ingersoll glarimeter) with the peak values of the goniophotometric curves, it will be observed that, although there is some tendency toward a correlation, an exact correlation is not observed and the two instruments generally failed to distinguish the differences in gloss shown by the peak values obtained with the goniophotometer. Papers having essentially the same Bausch and Lomb gloss values (samples 3 to 7) were observed to differ substantially in visual gloss and to display a relatively wide spread in peak values. The observed insensitivity of the Bausch and Lomb glossmeter in the testing of high-gloss papers is attributed primarily to the fact that the instrument is equipped with large source and receptor apertures; it is thus incapable of distinguishing differences in gloss which are readily resolved with the goniophotometer and which are also visually discernible.

The failure to observe a correlation between the Ingersoll values and the peak values of the goniophotometric curves (and visual gloss) is attributable, in part, to the fact that the design of the Ingersoll glarimeter is based on a principle of operation which for a valid evaluation of gloss requires that the index of refraction of the test material be 1.57. The Ingersoll gloss values obtained for the papers having the different indexes of refraction display the effects to be expected on theoretical grounds. All of the papers having indexes of the order of 1.56 possess Ingersoll gloss values ranging from 95.8 to 99% whereas those papers with indexes of the order of 1.32 have Ingersoll values of a lower order of magnitude—from 87.1 to 89.4. These small spreads in the gloss values also serve to indicate that the Ingersoll glarimeter is inadequately sensitive to differences in gloss which are readily discernible to the eye.

It is tentatively concluded from this work with the goniophotometric curves of "cast-coated" papers that physical quantities relating to the visual estimation of gloss for a given angle of illuminating and viewing are (1) peak value of the specular reflectance, (2) half-width of the peak (or any other suitable description of slenderness), (3) flatness of the paper surface, and (4) the color and luminosity of light diffusely reflected by the paper.

LITERATURE CITED

1. Hunter, R. S. "Methods of Determining Gloss." J. Research Natl. Bur. Standards, 1937: 18, 19, (R. P. 958).
2. Harrison, V. G. W., "The Definition and Measurement of Gloss," Cambridge, England, W. Heffer and Sons, Ltd., 145 pages.

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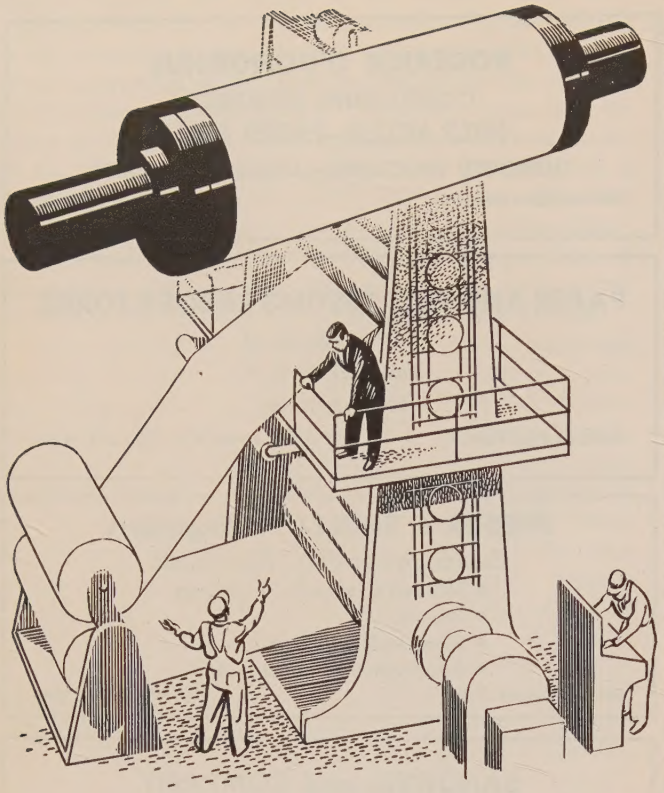

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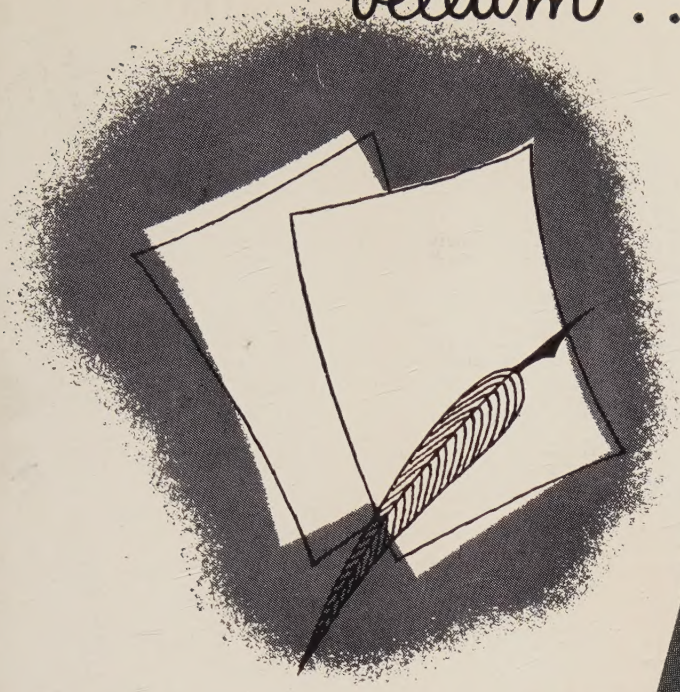

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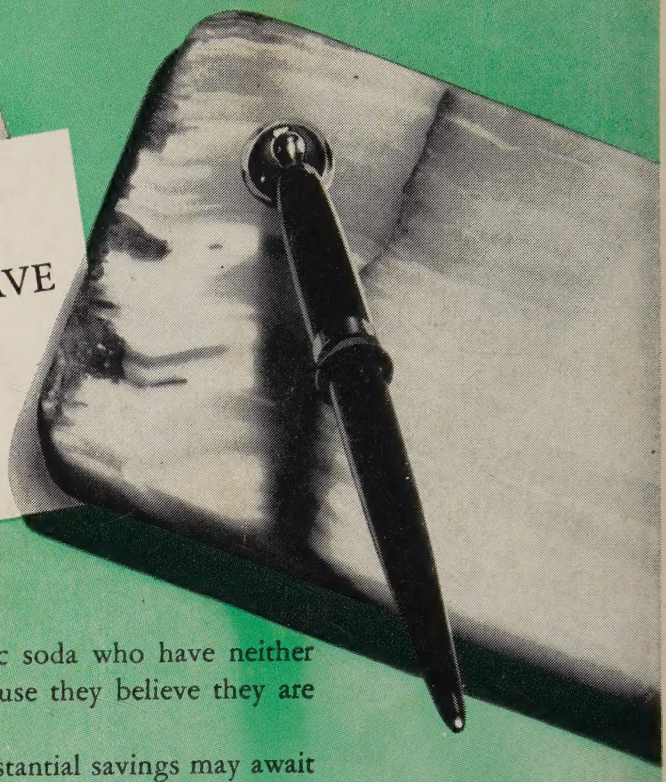

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